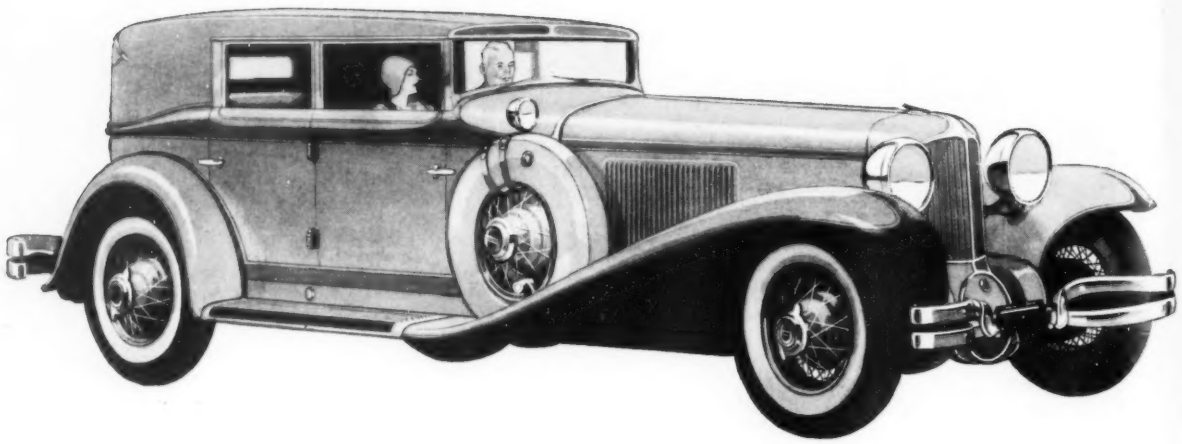
INDUSTRIAL NUMBER

Waste Reclamation • • Hydrogenation of Oil

SCIENTIFIC AMERICAN

NOVEMBER · 1930 35c A COPY

SPANNING THE HARBOR AT SYDNEY, AUSTRALIA



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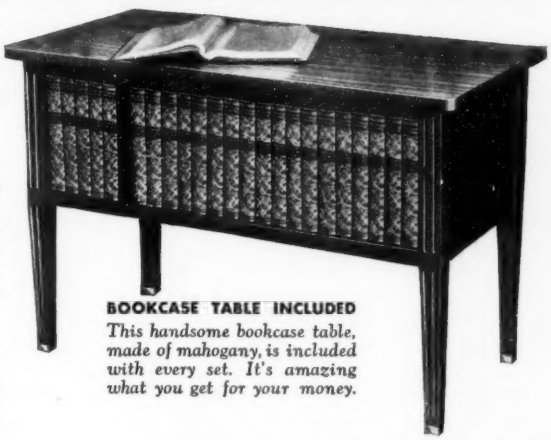

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SCIENTIFIC AMERICAN

ORSON D. MUNN, *Editor*

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EIGHTY-SIXTH YEAR

NOVEMBER · 1930

THIS MONTH'S COVER

Over Sydney Harbor, Australia, there is being completed a bridge that will be the largest of the arch type in the world. Its single span is 1650 feet long and its over-all length, including approaches, is 3770 feet. A deck 160 feet wide will be carried at a height of 170 feet above the water. Our artist, Howard V. Brown, has artistically illustrated this month a recent stage of the construction work on this bridge which, when completed, will have cost about 40,000,000 dollars.

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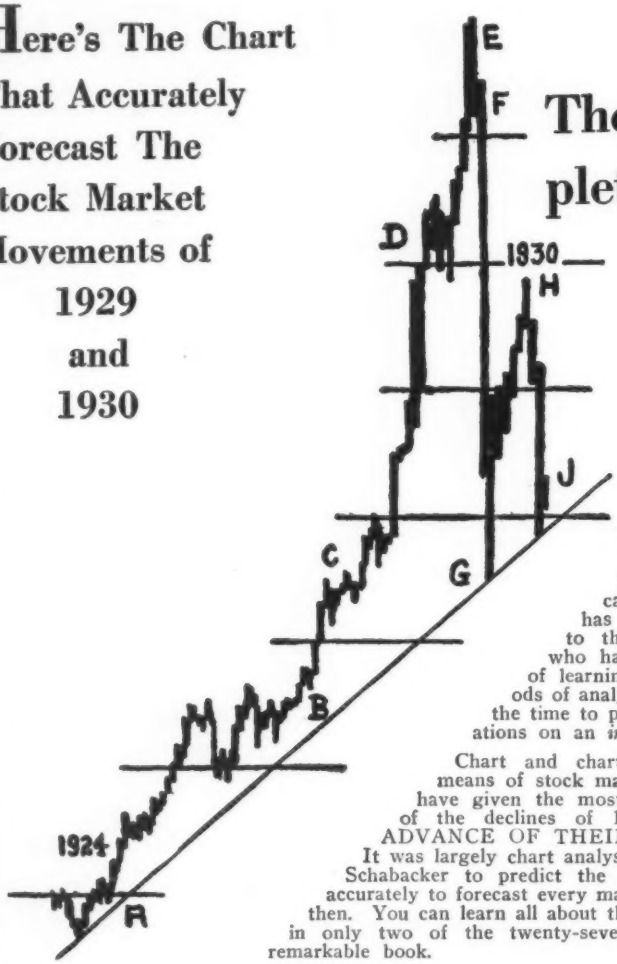
Here's The Chart That Accurately Forecast The Stock Market Movements of 1929 and 1930



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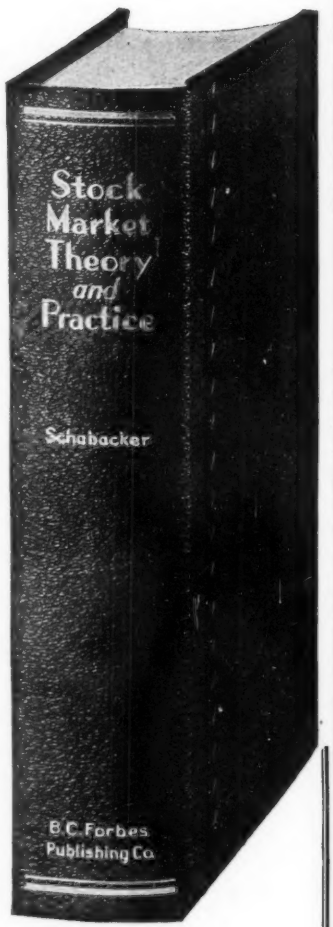

STOCK MARKET THEORY and PRACTICE

By R. W. Schabacker

Financial Editor of Forbes Magazine

In its wealth of information "Stock Market Theory and Practice" covers brokers' statements, tips, Exchange machinery, rights, stock charts, short selling, margins, pool manipulation, corporation statements, options, brokers' loans, money rates, price-earning ratios, market analysis and every other point on the stock market that may puzzle you.

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ACROSS THE EDITOR'S DESK

WE were chatting with the editor of another magazine the other day, as together we glanced through the advance page proofs of the feature articles in the present issue. "Why," he asked, "do you place so much stress on industrial subjects in the Scientific American?" "Because," we replied, "industry today is the child of science. Without science, there could be none of the vast industries that are scattered throughout the world. Men of science, in both the pure and applied branches, are constantly bringing to light new facts that make possible new industries and bring about radical improvements in the old ones. Therefore, we keep our finger on the pulse of industry and report its progress, hand-in-hand with science."

And in our answer to the friendly question will be found the why and wherefore of our annual Industrial Number which you have before you. On the surface, the layman may not see the closely woven connection between science and industry. But when he is taken behind the scenes and is shown how industry profits rapidly by the advantages offered by scientific research, he begins to realize the parentage of our so-called Machine Age, and therefore ordinary factors in our daily life take on a new interest.

One of the most significant articles in this issue deals with natural gas, a fuel that is coming into wide use in both industry and the home. Here is a subject that proves most aptly the point which we made above. Natural gas has been known for centuries, but only recently has it started to climb to a real position of importance in affairs of the world. And science is the factor that has provided the basis for this climb, by making transportation of the gas commercially practicable.

Waste, the bug-a-boo of many industries and businesses, is rapidly succumbing to the advance of research. Many manufacturing plants are finding that waste material which was formerly going up in smoke or down to the city sewer can be reclaimed and turned to profit. Science and industry again. Several phases of this work are described on pages 378 and 379.

The business of making motion pictures grew from infancy to a flourishing adolescence within the space of a generation. Then came a period of partial stagnation. For years, inventors had been working on methods to give a voice to the silent pictures, and at a critical point in that period of stagnation, synchronous recording of pictures and sound stepped from the laboratory and revived the entire movie industry. Today the talkie has largely replaced the silent motion picture, but it still has its defects. These are dealt with, and suggestions for improvements made, on another page.

As these pages go to press, we are starting to work on some of the articles which will appear in the December issue. Prominent among them will be one on another phase of Scientific Criminology, by Stanley F. Gorman of the New York Police College, whose first article on this subject, in the October number, aroused so much favorable comment. In the coming dissertation, Mr. Gorman conducts the reader through the ramifications of a murder inquiry, and clears up many erroneous impressions that the public has regarding police routine.

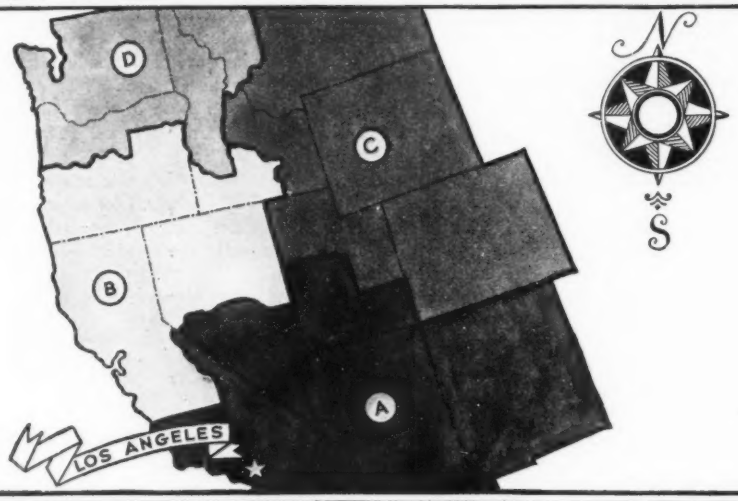
"Blind" flying may seem to be in the class of useless "stunt" flying until the layman realizes that the underlying purpose of instruction in this work is really to prepare the pilot to meet adverse conditions of visibility that are likely to be encountered at any time, even during short pleasure flights. The development of highly accurate instruments which tell the pilot all he needs to know, without the necessity of actually seeing the ground, has made possible rapid strides in safety in flight. "Blind" flying will be dealt with in a comprehensive manner in an article now ready for release.

If you are a manufacturer or inventor, you will not want to miss the descriptive article on a testing laboratory where the characteristics of anything from pins to refrigerators can be determined accurately for you. And if you are a consumer, you will be glad to see how your interests are protected in many cases by the exhaustive tests made in this modern "fault finding factory."

These are just a few of the high-lights that catch out attention as we go over the December schedule. Space is reserved for timely articles—spot news—that come up as the constantly changing panorama of progress unfolds. We also have ready for use articles on the new Raman effect in physics, crude oil, "What is a Quantum?" by Paul R. Heyl, the Mayas of British Honduras, X-ray "fingers" that reveal atomic structures, feeding the crew of a battleship, and other equally absorbing subjects.

Western Market

12 Million People



— served most economically from Los Angeles County

There is a distinct freight advantage in serving the Western Market of 12,000,000 population from Los Angeles County... its largest metropolitan center.

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Industrial LOS ANGELES COUNTY

POPULATION 2,199,657

Manufacturing Executives Are Invited to Write to the Industrial Department, Los Angeles Chamber of Commerce, for Detailed Information Regarding this Great Western Market

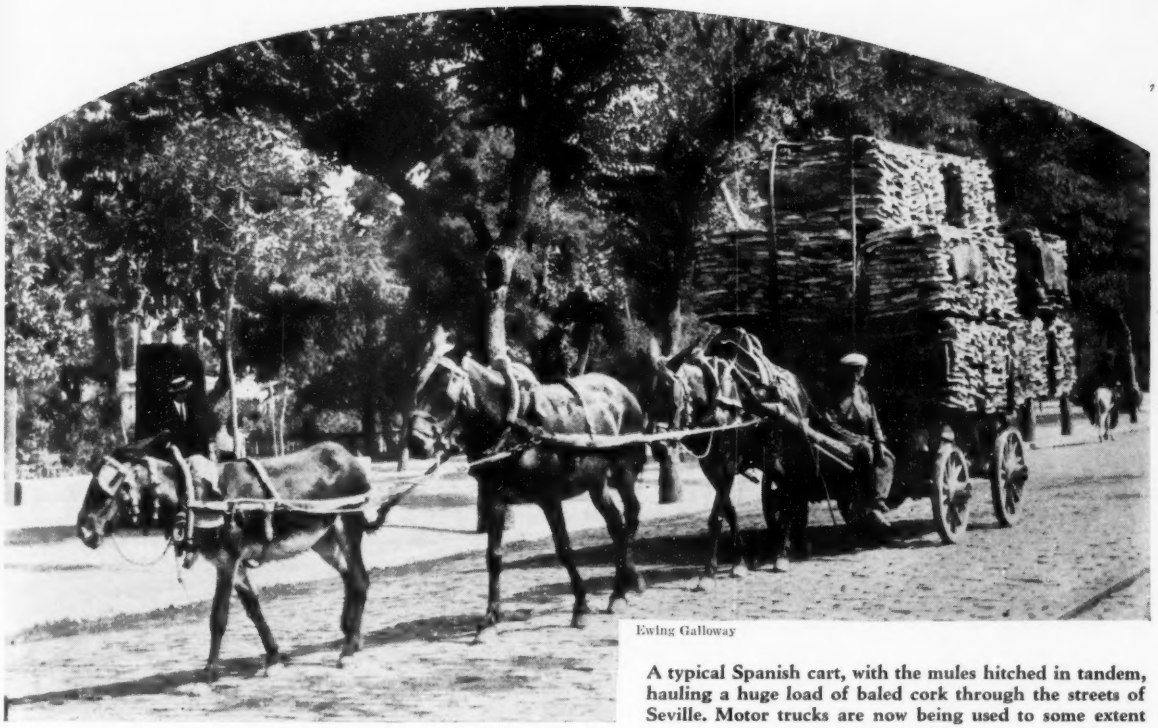
ANDREW WELLS ROBERTSON

A HIGH SCHOOL principal whose vision saw beyond the confines of school walls and whose understanding of men, fairness, and canny Scot's industriousness have carried him to the high position of Chairman of the Board of the Westinghouse Electric and Manufacturing Company—that, in brief, is the biography of Mr. Robertson. Like many other leaders in American industry, Mr. Robertson's family background is modest. His father, a native of Scotland residing in Panama, New York, was a stonemason by trade. He died when young Andrew was but three years of age but this did not prevent Andrew from getting an education. He was graduated from Allegheny College in 1906 and was principal of a high school for a time. He studied law while conducting a private school for boys and was graduated from the University of Pittsburgh in 1910 with the degree of LL.B. Admitted to the bar, he joined a Pittsburgh law firm, practiced privately for a time, and later became trust officer for a large Pittsburgh firm and attorney for another. By 1918, he had become general attorney for the Philadelphia Company, was made vice-president in 1923, and president in 1926. In 1929, he attained his present position with the Westinghouse company. He is a trustee of his two alma maters, a director of many large corporations and associations, and a member of New York and Pittsburgh clubs. Being an able speaker, he is much in demand on public occasions but has never been attracted to politics—he has been too busy for that.

Ewing Galloway

THE CORK OAK GIVES UP ITS VALUABLE OUTER BARK

THE cork tree is stripped, always during the summer, at intervals of about eight or nine years. After the stripping, the tender inner bark is, of course, exposed for some time until a new layer of cork begins to form. For this reason, the stripping is never done when a sirocco is raging, for the heat of the wind would cause undue drying. In the illustration, an expert cork harvester is shown cutting the bark at the legal height—this must be done very carefully so that no injury is suffered by the inner bark—and his helper is prying off the bark with the handle of his axe. In some localities, the larger limbs are also stripped, but this is not the general rule.



Ewing Galloway

A typical Spanish cart, with the mules hitched in tandem, hauling a huge load of baled cork through the streets of Seville. Motor trucks are now being used to some extent

THE TREE BARK OF A HUNDRED USES

By BURTON DAVIS

WHEN the dry sirocco sweeps up off the Mediterranean and blows its hot breath on the Latin lands that border it to the north, there is one tree that remains gayly green. When the simoons twist north from the parched sands of the Sahara and whirl across Algeria, Tunis, and Morocco, one evergreen oak flourishes. That tree is protected by nature with a thick layer of the finest natural insulation in the world: you know it as cork.

All woody plants have a coating of cork, but this one sort of oak has more than any other. Certain elms and birches elsewhere in the world have outer bark that resembles it, but theirs is comparatively useless to man. The outer bark of *Quercus suber* and its almost identical cousin, *Quercus occidentalis*, known as the cork oaks, is in many ways unique in nature and invaluable in human industry. Nothing natural nor artificial has yet been produced to compare with it, for the *Quercus* bark has seven properties: resistance to the passage of moisture and liquids, buoyancy and light weight, resilience and compressibility, ability to absorb sound and vibration, strong resistance to progressive deterioration, low conductivity of heat, and an uncommonly high coefficient of friction.

Through at least 2300 years, these properties have successively been discovered and utilized by man. Yet, although cork now has more than 150 distinct uses in the complicated apparatus of civilization, little is known about the physiological, physical, and chemical properties of the odd material.

ALL the literature on the subject of cork, including reports of previous research, could be carried in a small brief case. The men who have handled cork throughout the ages never bothered to find out much about it. A dozen chemists and botanists had worked on the problem of explaining how it grew and of what it was made up, but from 1787 to about 1927, had chiefly developed theories that were later discarded.

There was no accurate information on the number of cork trees in the world and how much cork bark they could supply. Man was using a natural resource and might reach the limit of its supply. Reforestation of cork oak had been largely left to nature and rare private enterprise. Culture of the cork oak was not fully understood. All this had to be studied so that provisions could be made against the future.

And that was what the American cork manufacturers set out to do less than a year ago. Since then another factor has loomed up. Apparently we are about to enter another ice age, this time in food distribution, for huge plants are being built for the quick freezing of meats, fish, vegetables, and fruits to be retailed in packaged form, hard frozen, and kept at sub-zero temperatures. Such low temperatures in freezing plants, refrigerator cars and trucks, storage cases, and household iceboxes will demand cork-board in huge quantities.

Cork, therefore, has rather suddenly become an object of keen industrial interest. The factories called in the research doctors and set them to work to find out how cork is put together, of what substances, and, in exhaustive detail, what its physical and chemical properties and peculiarities are beyond the known and obvious ones. Cork was such a mystery that there was no predicting what they might uncover. To develop a satisfactory substitute for cork is one of the things the scientists hope to do, although at present that

Underwood & Underwood

Cork oaks partially stripped of their valuable bark in a scattered grove at Almorasma, Spain

seems to be a hopeless, impossible task.

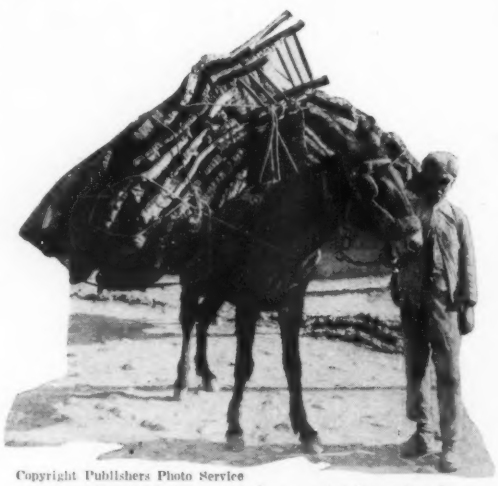
In the research and testing laboratories of a large cork company at Lancaster, Pennsylvania, only lately a photomicrographer took the first picture of the individual cork cell. The research, by scientists attached to the company, that led up to the taking of this picture—as well as the picture itself which is reproduced on page 347—showed that the cell has the geometric form known as tetrakaidecahedral.

This difficult word is from the Greek and means "having 14 faces." Lord Kelvin, years ago, found that units of 14 faces solved the problem of dividing all space, without interstices, into uniform bodies of minimal surface. In 1928, Dr. Frederic T. Lewis, of the Harvard Medical School, conducting independent research into cell structure, demonstrated that cork cells are tetrakaidecahedrons, each making contact with an average of 14 others.

EVEN though there are minute interstices between cork cells, these are filled with resin that is impervious to water and most liquids. Obviously a substance, the cells of which fit so snugly, is going to baffle the passage of any fluid which is unable to eat its way through. Thus the word for cork is the word for stopper, also, in most languages—a "stopper" is a "cork."

The first of the seven properties of cork, then, made the stopping of wine and oil jars one of its first uses. Horatius Quintus Flaccus (Horace) spoke of that in Ode III, 2000 years ago. Earlier than that, doubtless, the ancients had used the second property: buoyancy and light weight. Pausanias (not the Spartan admiral, but the traveler and geographer of the 2nd Century, A.D.) recorded that cork bark was used for anchor boards and on fish nets. Since each cork cell is more than half filled with air, the mass is buoyant. Its specific gravity is between .15 and .20, making it one of the lightest of solid substances.

The cell walls of cork are of tough, highly elastic material—much more so even than rubber—hence its resilience and compressibility. At Lancaster a one-inch cube of natural cork was recently put under pressure of 14,000 pounds to the square inch. The sidewise spread under that load was only a quarter of an inch. Released, the cork in a few hours regained between 90 and 95 percent of its original height, while the horizontal edges of the cube returned to exactly one inch. The secret of cork's unique behavior appears to be that only the air in the cells is compressed, hence the lack of side spread and the unequalled regain. Corks jammed in champagne bottles for 10 years will regain three-quarters of their original volume shortly after being withdrawn from the bottle.



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Sure-footed burros, top-heavy with huge loads, transport cork in the mountainous sections

Since dead air, in finely divided spaces, is, next to a vacuum, the best insulator known and the poorest conductor of sound and vibration, the fourth and sixth properties of cork are easily explained.

What will keep out heat will, in the popular phrase, "keep out cold"—which means it will keep heat *in*. Hence the use of cork-board insulation, which threatens to outstrip every other use of the cork in a few years, not only to insulate refrigeration units but also to insulate buildings against the winter's cold and the summer's heat. That last-mentioned use may have been the first to which cork bark was put, for the peasants all over the cork oak country still roof and wall their huts with slabs of the crude cork.

THE known chemical inertness—except to a few acids and strong alkalies—of the walls of the cork cell and the intervening resin explains cork's uncommon resistance to deterioration.

The fourth and seventh properties in the list have been the last to be utilized. Cork has only lately come into general use to absorb sound and act as a corrector of acoustics in echo-haunted halls and rooms. The first use in this respect was of cork tile as flooring for libraries and hospital halls. Now whole auditoriums are lined with a fine-grained cork-board. Radio broadcasting and sound film studios are using cork to exclude exterior noises, reduce interior sound and vibration, and break up echoes. Lastly, cork, long applied to reduce vibration and clatter in machinery of a hundred kinds, is now being used in slab form to insulate machines, from light fans to enormous engines and dynamos, against the transmission of vibration and noise.

The seventh property of cork—its high coefficient of friction—has been put to use only since the machine age came in. When cork bark is sliced cleanly, a surface is created exposing tens of thousands of hexagonal open cells to the square inch, each acting as a tiny vacuum cup. This, and the unusual resistance of the cell wall to frictional wear, gives cork the gripping and polishing properties now widely utilized. Plate glass mirrors and windows, fine glass and crystal, and optical lenses are polished on cork wheels. Leather and rubber both wear slick in short order,

for their cell material has little of the toughness of cork's mysterious material, called "suber," which is neither cellulose nor wood fiber.

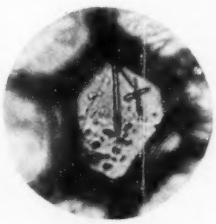
In the Lancaster testing rooms, one-inch squares of cork, belting leather, and rubber, all designed for the same use, were equally weighted and placed on an inclined plane. When the plane was inclined 18 degrees from the horizontal the leather slid down. At 28 degrees the rubber went coasting. Not until the plane was slanting 42 degrees did the cork creep down.

THE temptation in discussing the seven properties of cork is to wander off into fascinating bypaths to tell of the applications of cork that derive from these seven traits. They range from the tiny pieces in the pincers of pince-nez eyeglasses to the acres of cork-board, up to 12 inches in built-up thickness, in the walls of the quick-freezing meat packing plant of 1930; from the cork-lined cap of the tooth-paste tube to the newest and most uncommon use of cork in a planetarium. The first of these in America, recently completed in Grant Park, Chicago, has 9450 square feet of cork-board insulation on the dome.

The story of how and where cork grows, how it is gathered, prepared, transported, manufactured, and used, can only be sketched, for a full description of these fascinating phases would overflow this issue.

With a cork oak acreage of 550,000, Portugal leads the world with a production of 80,000 metric tons of cork; Spain is second with a production of 75,000 metric tons from 637,500 acres; Algeria is third with a production of 27,000 metric tons; while France, Tunisia, Italy, and Morocco come next in order; and even Japan produces about 400 tons of inferior cork yearly.

When part of a grove of cork trees has attained an age of about 20 years—for the first cutting—the expert cutters, each helped by apprentices, start to work. The expert makes a careful cut, with a tomahawk-shaped hatchet, around the trunk just above the exposed roots—in Algeria he may use a circular saw—and another just under the lowermost branches. These he connects with two vertical cuts, following the biggest natural cracks. The assistants help him pry off the bark. All this is done with the finesse of a surgeon, for any injury to the inner bark, or *phellogen*, which builds up the cork, results in a scar area over which no new cork will ever grow. This first cutting of bark, called "virgin" in Spain and "male cork" in France, will sell for a low price, to be used in the rough for florists' baskets, arbors, ferneries, and to be ground into low-grade granulated cork.



Right: **Photomicrograph of the cork cell. Six cells are shown touching the central one at the point of cleavage**

Nine or ten years later, the cutters will be back in that same grove, removing the new growth of cork, of finer grain and in every way more valuable. In some places they will also strip the bigger parts of the chief branches; in others, restrained by law or local regulation, they will wait for about five years, strip the large branches, and four years later denude the trunk again. In the French government forests—about half of those in Algeria and Tunisia—stripping the branches is prohibited. In some private forests of Spain the cutters may go back after eight years. In Portugal the law demands a wait of nine years, and the first crop cannot be removed until the tree is 15½ inches around, three feet above ground. Each crop after the first is progressively better until the tree is about 40 years old. Thereafter it may be expected to continue to produce fine cork until it dies, at from 100 to 150 years.

Underwood & Underwood

After the cork has been cured and dried flat, it is trimmed and packed in bales for shipment

Copyright Underwood & Underwood

Great stacks of the cork as it comes from the trees. In foreground, a bale ready to be shipped

Virgin cork is bought with no particular care, on a weight basis. But from the second stripping on, the value of the cork makes buying a careful balance between buyer's and seller's ideas of its worth. The cork buyer is an important personage, for on his judgment profits are made or lost. He migrates with the cork cutting season, penetrates all manner of country and deals with all manner of cork grove owners, cutting contractors, and government officials.

Arrived at a certain stand of cork, in advance of the cutting season—April to June in North Africa, July and August in Europe—the buyer sends his sampler through the grove on a beeline. With a cylindrical punch, the sampler cuts out a disk of cork from every 5th, 10th, or 20th tree and jumbles these in the huge sack on his back. At the buyer's office these are scrutinized with care, for on the average of them the buyer will base his bidding for so many tons of cork, perhaps for the stripping from a whole mountainside. In the French gov-

ernment forests of north Africa, however, the cork is gathered at stations to be sold at auctions.

To return to the typical scene, say in Spain or Portugal: The stripped cork bark is piled up in the grove and left a few days to dry. Then it is weighed on a "romana," a type of yard scale introduced by the Romans 2000 years ago.

Ewing Galloway

The cork industry in southern France is the same as it is across the border in Spain. Above is shown a girl operating a cork cutting machine that reduces strips into cubes which are later cut into bottle stoppers. At the right a girl is operating by hand a machine that cuts the stoppers from the cubes

(Cork harvesting methods have changed little in 20 centuries.) The bark is carried on burro back or in carts to the boiling station at the edge of the forest nearest the market or the railroad line.

Boiling the curved slabs in large vats fired with dead corkwood softens the bark so that the rough, creviced, outer layer can be scraped off by hand with a flat tool. This process removes about 15 percent of the weight of the slab, removes the tannic acid from the cork, increases the volume and elasticity, and makes it possible to dry the slab flat. After being roughly sorted for quality and thickness, the dried bark is loaded on sturdy burros, which pick their way carefully down the mountain trails to the railway station, topheavy with a huge pile of the light bark aboard, bigger than the animal himself. As roads in Spain and Portugal are improved, motor trucks are replacing the picturesque burro.

ARRIVED at the warehouse and manufacturing center the crude bundles are opened and the rough edges trimmed off the slabs. Another grading for quality takes place, dividing the cork into about 25 classes. The bark for export is baled in a hand or a hydraulic press, bound tightly with iron straps, and stenciled. The bale is then ready to be loaded into the hold or on the deck of a steamer. Philadelphia, New York, or Baltimore will be the destination of nearly all of the exported crop; the rest will have gone to the stopper cutting shops nearby, the trimmings and "waste" from which will also be baled for export to the cork composition or linoleum factories overseas.

One manufacturing company has its own receiving plant at Gloucester, New Jersey, just below Philadelphia, where the various grades are separated and sent to various plants. At Pittsburgh, where the finer grades are made into bottle stoppers and other natural cork products, the final sorting puts the bark into as many as 80 bins, the grades differing so little that only the expert can detect the difference.

At this point the story of cork divides into four stems: the business of making bottle stoppers and natural cork products; the distinct processes used to make cork composition products out of scrap and grinding grades; the process carried on elsewhere which turns out cork-board for insulation, machinery isolation, and corkoustic; and the complex business of making linoleum, linotile, and other flooring material.

The key to this maze is the utilization of waste. Automatic machines punch bottle stoppers out of the best of the bark. The punched-out strips are ground into flour for linoleum or granulated for making cork composition. The coarser cork is ground into larger granules to be pressed, at high temperature, into cork-board slabs, the natural resin forming the only binder used.

Natural cork is used for pistons for plunger fountain pens and for wind musical instruments; seine and gill corks for fishing nets, and bung corks and artillery practice wads. From natural cork are also made disks for bottle crowns and patent caps, bulletin boards, penholder grips, cork balls for games, plasterers' floats, and many other products.

CORK composition is used for box toes, counters, insoles, heel lifts and pads, and bottom filler in shoes; also, in all manner of gaskets to stop leakage of gasoline, oil, or water; in churn strips, bobbers or floats for fishing lines, and so on.

In the automobile, cork and cork composition may be used in as many as 50 places, most of them unsuspected by the owner.

Linoleum is made from cork flour, as described in the October issue of SCIENTIFIC AMERICAN. Linotile, a tile of linoleum composition, is laid in special patterns by hand and produces marble and tile effects. Cork brick, non-skid, almost impervious and resistant to acids, is used in dairy barns and modern pigsties for better sanitation.

Underwood & Underwood

Cork carpet, made of coarser cork, is used particularly in public buildings where sound deadening is important.

Granulated and regranulated cork is used for packing fine china and glass, grapes, and other fruits. Despite modern industrial advances, cork holds its own as one of the most useful of natural substances, although it is still one of the most mysterious after 2300 years of use; in fact, it is playing an increasingly larger rôle in the drama of industrial progress.

OUR POINT OF VIEW

ACROSS THE ATLANTIC

NO transatlantic flight or attempt to make an airplane crossing of this stormy ocean since the unsurpassed flight of Colonel Lindbergh, in May, 1927, has so fired the imagination of the world as the three successful westward flights this summer. A Briton and a German made the first two flights, each with one or more stops, and the climax came when a Frenchman, already famous and a hero among his people, made a non-stop flight from Paris to New York in a plane that was also already famous for its share in his exploits.

In June, Wing-Commander Charles Kingsford-Smith, with E. Van Dyk, Captain J. Patrick Saul, and J. W. Stannage, flew from Ireland to Roosevelt Field, Long Island, in the *Southern Cross*, making one stop in Newfoundland. His flight marked the completion of a spectacular 'round-the-world air trip which had started over a year previously. In August, Captain Wolfgang von Gronau, with Edward Zimmer, Franz Hack, and Fritz Albrecht, made an unheralded flight from Germany to New York Harbor, with stops at the Faroe Islands, Iceland, Greenland, and Nova Scotia. His flight was praiseworthy for two reasons: first, because in this day of blatant exploitation of air feats, his was a surprise trip, few knew anything of it until it was over, and, so far as we know, he has not commercialized it; and secondly, because his route may prove the most feasible when transatlantic airplane services are inaugurated.

When Dieudonné Coste and his copilot, Maurice Bellonte, landed the red *Question Mark* at Curtiss Field on September 2, the final chapter in the long and tragic story of the conquering of the stormy north Atlantic by airplane was written. They had taken off from Paris 37 hours 18½ minutes previously. To these two daring fliers go, therefore, the laurels for the first non-stop crossing of the north Atlantic by airplane from the continent of Europe to the United States. They have accomplished what many others before them had tried and what they had unsuccessfully attempted in 1929.

Aviation owes much to these pioneers of 1930. When and if airplane service is started across the Atlantic to and from the United States, the lessons learned by their flights will have much influence in the choice of routes, modes of operation, and so forth. But we consider that the pioneering has now been completed except in cases where totally different types of planes—such as the Dornier *DO-X*—may be involved, and will frown upon any further individual attempts to conquer the Atlantic. Such transatlantic flights will seem to us to have the taint of commercialism or to be inspired by individual desire to exalt an already inflated ego.

GAS FROM THE EARTH

ON page 380 of this issue we publish the story of the amazing growth of an industry about which little is known: that which has been and is being built up around natural gas. Possessing about twice the heating value of artificial, or manufactured gas, this natural mixture from the earth's reservoirs has been used commercially for over 60 years but has only recently become an industry of huge proportions because of recent technical developments that have shown the way to discovery of large natural gas reserves and have made possible long distance pipe-lines.

During the current year, the natural gas industry has expanded at a greater rate than perhaps any other industry of importance—and that despite world-wide business depression. Its increase in pipe-line mileage from 80,000 to 90,000—including pipe-lines put into operation and also those on which construction has been started—represents an increased capacity of more than 12½ percent. *The Lamport Review* estimates that this 10,000-mile increase adds "at least 250 million dollars to capital investment" in the industry.

Truly this is the bright spot on the business horizon. It puts to shame many other industries that have not progressed this year—yes, despite the depression—and teaches a lesson of research and development, farsighted belief in the future and rapid expansion. The confidence of the men behind it is worthy of the highest praise.

FUTURE AIRSHIPS

SHORTLY after the successful flight of the *R-100* from Cardington, England, to Montreal, Sir Dennistoun Burney, its designer, outlined a new proposal to establish a transatlantic airship service in which he attempted to prove that a company possessing four or six new ships twice the size of the *R-100* could operate with profit.

Such proposals are not new, but the fact that this one takes such definite form indicates that the time when a transatlantic airship service of some kind will be a commonplace thing draws rapidly nearer. In the face of this fact, American vision apparently does not see as far ahead as does Sir Dennistoun. We have under construction two airships that will be far larger than any heretofore built but beyond construction of these two we have no plans for the future—unless they be deep, dark secrets. And even for each of these two dirigibles, we are importing eight Maybach engines from Germany. This may have no very great significance but to us it is indicative of the passive interest of American engine manufacturers in the development of American airship engines.

One of the many criticisms of the dirigible is that it is bulky. True, but *The Engineer* (London) points out that its weight per passenger is only 1.56 tons as contrasted to nearly 24 tons per passenger of the liner *Mauretania*. Fuel consumption is not considered excessive; and transatlantic passenger and mail rates little in excess of steamer rates are to be expected.

But aside from all such arguments, the airship is with us and we believe it will stay, although no one can predict its ultimate status. Why, then, American apathy toward developing it to the fullest extent? Much experimental work is yet to be done but we should like, particularly, to see some intensive research done toward developing an American airship engine.

INTERNATIONAL AFFAIRS

Navy Day

OCTOBER 27TH, Theodore Roosevelt's birthday, is Navy Day, and at every Navy Yard and on every man-of-war the Navy personnel will be at home to the American people. All who can should take the opportunity to visit the nearest ship or station, to show their interest in the officers and men who are our first line of defense.

In time of war we lavish praise on our Navy; in time of peace we are too likely to forget it. We take the efficiency

(*Please turn to page* 409)

RADIO CHARTS THE UPPER AIR*

By JEROME D. VAN BRAKLE

SIGNAL CORPS engineers of the United States Army have devised a means by which radio can be used to determine air conditions several miles above the surface of the earth, and after more than seven years of experimentation they have perfected, at the Signal School laboratories at Fort Monmouth, New Jersey, equipment by which the direction and velocity of the winds at high altitudes may be computed with a high degree of accuracy regardless of visibility.

Visual observations of upper-wind conditions are impossible at night and when visibility is reduced by low-lying clouds or fog. Since many war operations are carried on behind smoke screens or after dark, it became necessary to devise a method of obtaining the desired upper-air information under these conditions for Army use. The radio method was the answer to the problem.

THE radio device, perfected at Fort Monmouth, consists of a miniature continuous-wave transmitter which is sent aloft by means of three hydrogen-filled balloons. Its flight is followed with a loop direction finder, a process known as "tracking" or making a "balloon sounding." Long research was necessary before an efficient direction finder was perfected, as it was found that the commercial instruments used in radio compass work were not sufficiently accurate for meteorological use.

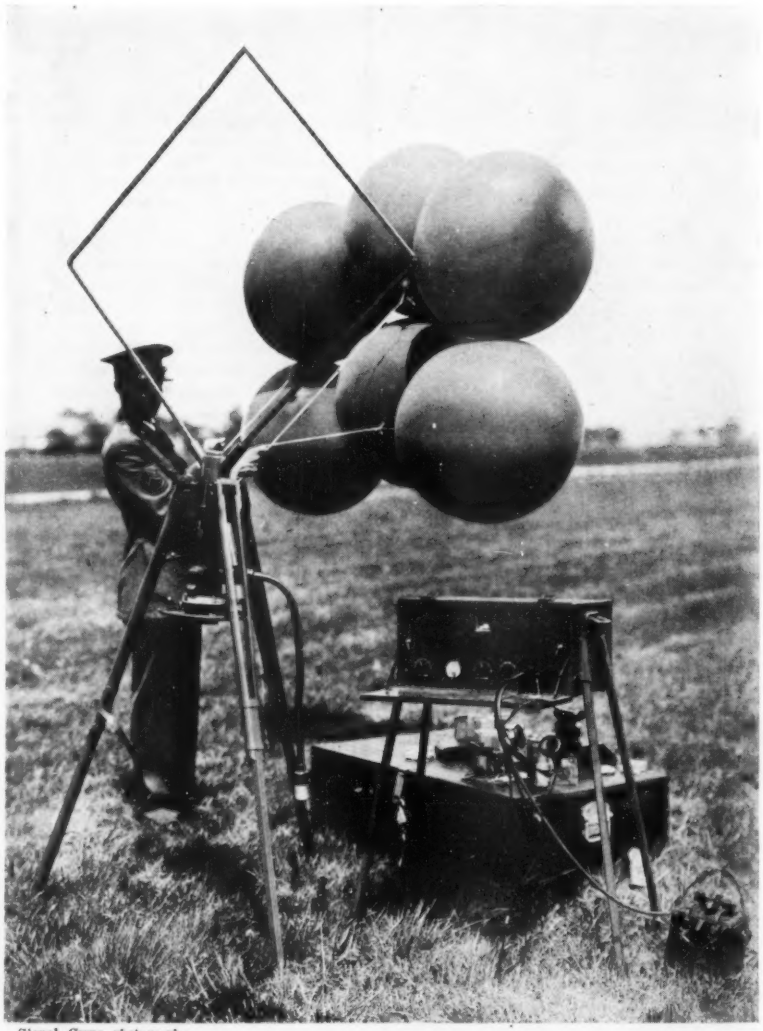
The loop direction finder consists of a specially-built radio receiver of rugged construction connected to a loop antenna composed of a single tube of copper, mounted on a tripod base. To the shaft of the loop is connected a calibrated dial, graduated in degrees and fractions. This dial is used to measure the angles through which the loop turns. Except for the fact that the receiver is of the regenerative type, Signal Corps authorities refuse to divulge the details of its construction.

The transmitter which goes aloft with the balloons is compact and sturdy and weighs less than a pound. It consists of a small vacuum tube, an inductance coil of enameled wire, a small transformer, and a small flashlight battery, the whole outfit costing about five dollars. When the battery is snapped into place at the bottom of the device, continuous-wave oscillations are started which will continue for more than two hours. This wave has been picked up from a distance of 15 miles.

The length of wire which connects the transmitter to the balloon cluster acts as an antenna. Signals are sent at a constant frequency of 2300 kilocycles or 130.5 meters.

When the balloon cluster, carrying the transmitter, is liberated it ascends vertically, because of the hydrogen gas, but at the same time it is blown about by the winds it encounters. This lateral motion is recorded by observers and from the data obtained, the speed and direction of these winds may be accurately determined.

It has been found that the cluster will rise at the rate of approximately two hundred yards a minute and that this rate of ascension will continue until the internal pressure of the hydrogen gas exceeds the outer pressure of the rarefied atmosphere and one or more of the balloons burst. Usually only one bursts and then the others act as a



Signal Corps photographs

The direction finder receiving set and the balloons for carrying the radio transmitter, used in the newly developed method of determining upper air currents

*Published by permission of Major General George S. Gibbs, Chief Signal Officer, United States Army.

parachute and gently lower the apparatus to earth with little damage.

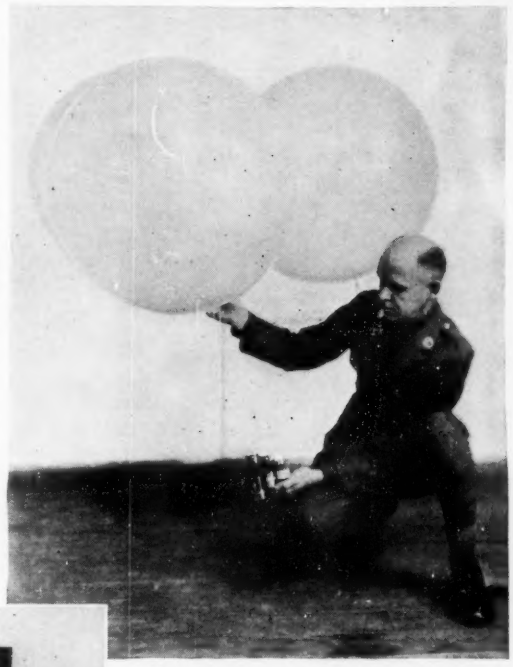
While the balloons are in flight, observations are taken by two direction finders set up on a base line of known length. Experiments have shown that this length should be three miles for the best results, although shorter distances have been used with a high degree of accuracy. Sometimes three instruments are used; then they are set up in the form of an equilateral triangle of known sides. The third instrument, however, is used principally as a check on the others.

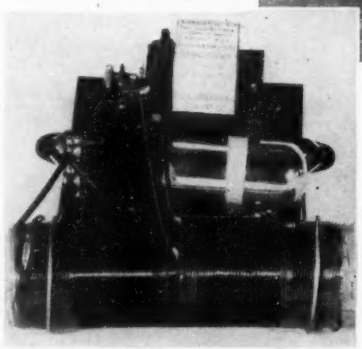
AFTER the release of the balloons, operators obtain bearings on them every minute. Accurate time is given by a clockwork device which emits a howl at the end of each minute and a warning buzz ten seconds before the minute. The bearings are telephoned to an observer at a plotting board where they are entered on a scale map. The point of intersection of each set of two bearings shows the exact position of the transmitter at any minute. From these data it is simple to determine the horizontal flight of the apparatus and by means of a special protractor and a wind scale, the required velocity and direction of the wind at each level of altitude is computed. Balloons may thus be tracked for several miles.

The observers at the loops base their calculations upon the zero point, where the signals from the transmitter are not heard. The loop is revolved until the signals disappear and the angle is read from the scale on the shaft of the loop. At the zero point, the plane of the antenna is at right angles to the direction of the transmitter. One of the points of high efficiency of the Army receiver is that the zero point does not vary until the transmitter is more than three miles from the receiver, then the variation is so small that accurate results may be obtained for seven miles and usable results for several miles further. Experiments have shown that the zero point in commercial sets splits before the transmitter is a mile away, greatly lowering the efficiency.

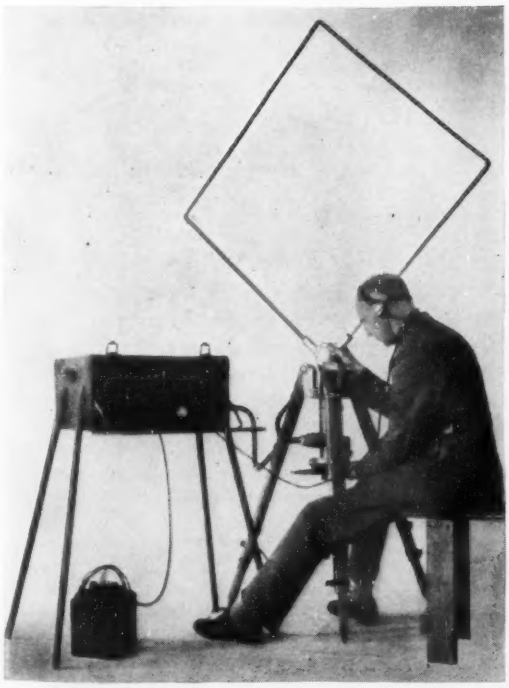
While the new system was undergoing preliminary tests at Fort Monmouth, simultaneous readings were made by radio and visual methods. These experiments showed that the radio method gives more accurate results as the continuous signal can be more easily traced. The visual method is more commonly used, however, because of the greater distance possible and because of the economic phase.

In the Atlantic seaboard states, where the prevailing winds are easterly, most of the instruments sent aloft are lost in the ocean, but in the Middle West, 95 percent of the transmitters are recovered. To insure the return of as many of the transmitters as possible, a notice is attached to the set offering a small reward to the finder if the instrument is sent back to the base station.





Above: **The one-pound short-wave transmitter attached to balloons.** ***Left:*** **A close-up of the transmitter. The battery is behind the instruments**



The direction-finder loop in use. The operator swings the frame, listens to the signals, and reads the angle

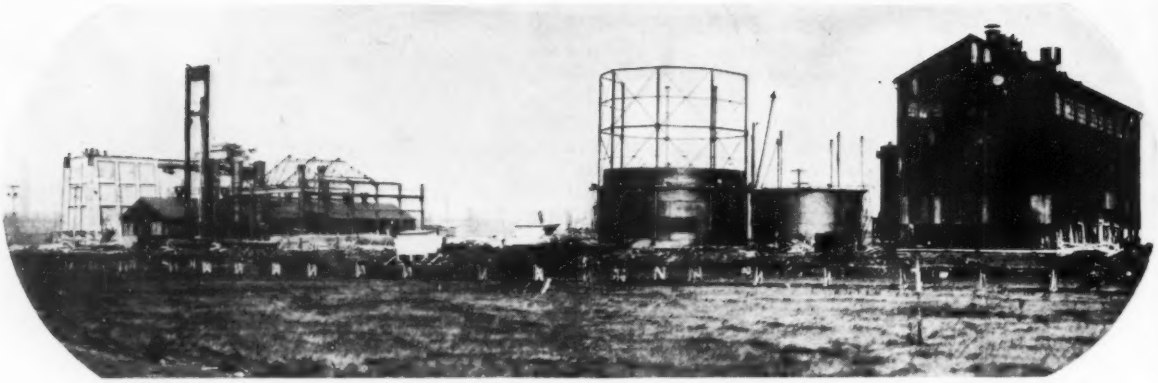
At Fort Monmouth, one day recently, a farmer drove up to the reservation in a dilapidated farm wagon. He walked up to the meteorological officer and handed him one of the transmitters which had fallen on his farm.

"You came mighty near not getting this contraption back," he declared. "When it came fluttering down in my cornfield I thought it was some new kind of bird and I almost wrecked it with my shotgun."

Although many of the instruments are returned in peace times, few recoveries would be expected in time of war. The cost of the apparatus in comparison with its utility and the value of the information it gives is so small that little thought would be given to the loss.

AT the present time, radio officers at Fort Monmouth Signal School are experimenting to find a method of determining upper-air temperatures by radio. A bi-metallic plate of variable capacity at different temperatures has been inserted in the circuit of the transmitter just described. It is designed so that the wavelength will vary as the air temperature increases or diminishes and these wavelength changes will be noted on the ground by means of suitable instruments.

Now that the common wind vane has been lifted high into the air by means of radio, it is the ultimate aim of these agents of Uncle Sam to use the radio device, with variations, to unfold many other secrets of the upper air currents.



Hydrogenation plant of the Standard Oil Company of New Jersey under construction at Bayway

A GALLON OF 'GAS' FROM A GALLON OF OIL

By HENRY W. HOUGH

"OIL DIPLOMACY" is the title of a long chapter in Ludwell Denny's arresting new book "America Conquers Britain" (Knopf), a remarkable record of economic war which is taking place today on a worldwide front in the form of bitter struggle between America and Britain for world markets in major commodities. The struggle takes its most violent form in oil. The most powerful world participants in the great contest are the vast Deterding interests (Shell) of Great Britain pitted against the Standard interests of America. The oil reserves of the smaller nations—Persia, Mexico, Colombia, Venezuela, and so on—are the rich fruits of battle. The accounts of some of the dealings between the rival giants make fascinating if somewhat grim reading; the international oil war is not a game of tiddleywinks. Ostensibly the oil war between America and Britain is conducted by private interests but Mr. Denny reveals that both governments have taken a hand. And why not? Oil is a national asset; without it no nation today can remain a first class power. Britain is not losing the oil war; we are. She has largely outwitted us, gaining control of the best resources. We are left holding the bag. "The public has been in no mood to champion the cause of any oil company at home or abroad," Mr. Denny writes, "but this sentiment is changing. The danger point will be reached when a near-shortage drives prices upward and American automobile owners are told the British have cornered most of the world supply." Britain is keeping much of her own oil supply intact and cleverly finding ways to exhaust ours. The Bergius processes, described in Mr. Hough's article, are German in origin and Standard has obtained them, but the cheapest oil at present comes from the ground. When the American people finally wake up about the oil situation will it be too late?—*The Editor.*

LAST season, or perhaps it was the preceding season, a thrilling drama was witnessed by theatergoers. It involved a young genius who had made a scientific discovery of startling significance. He proved that he possessed the power to blow the world to smithereens. His secret was known only to himself. Anxiety and apprehension resulted—until the closing scene of the play.

Another drama almost equally exciting although somewhat less sinister now is being enacted before a much larger audience. The opening scene was in a laboratory in Germany, and centered about the research of the noted investigator, Dr. Friedrich Bergius. The scientific world was amazed by the news concerning his hydrogenation process for converting wood into coal, coal into oil and gasoline, and so on.

NOW the scene has shifted to America. About a year ago the rights to Dr. Bergius' process were acquired by the Standard Oil Company of New Jersey, in affiliation with the I. G. Farbenindustrie or "Dye Trust" of Germany. With the news of this merger, which followed three years of co-operative examination of the technical and commercial possibilities of the process, there came another startling announcement: "It now is commercially practicable to produce 100 gallons of gasoline from the running of 100 gallons of crude oil, by the addition of gaseous hydrogen under high pressure and high temperature in the presence of certain catalytic agents."

These developments have aroused rather than allayed the fears of those who anxiously await the outcome. Will the next scene show chaos in the petroleum industry? With over-production of oil constantly worrying the producers, must they now face a flood of cheaper "artificial" gasoline?

The petroleum industry has waited rather impatiently for further progress reports. The general public has exhibited similar interest, for today "the man in the street" is not only a consumer of gasoline and oil, but also is on the lookout for investments which seem to have great potentialities.

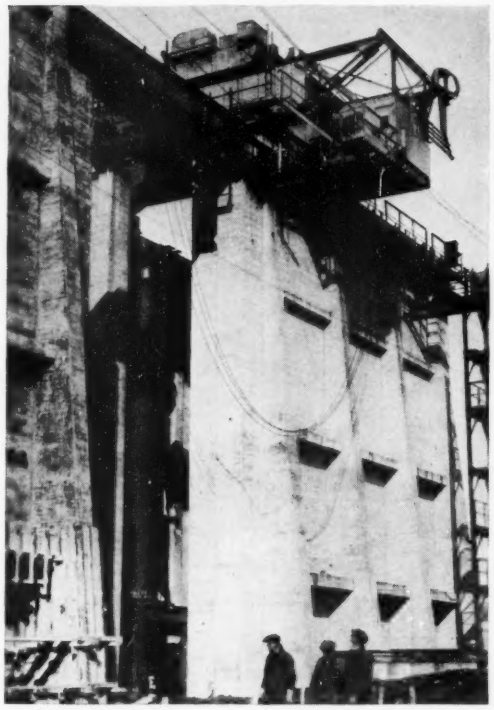
With the opening, a few months ago, of the first of three 5000-barrel-a-day hydrogenation plants, it seems that the Bergius process at last is ready to become an important factor in the petroleum industry. The first commercial plant is located at Bayway, New Jersey. Two others are to be built soon, one in Louisiana at Baton Rouge and another in Texas at Baytown. These plants are more than experiments, for each is a large-scale commercial unit based on the results of several years of intensive research and development. No effort has been spared to perfect the conversion apparatus and the methods of operation best suited for commercial production of gasoline and light oils.

To the layman, who may have grown weary of hearing about over-production in the oil industry, it may seem that hydrogenation has been born too soon. Even in the face of solemn warnings that the world's supply of petroleum

can last only a few more generations, there are many who feel that at present there is no place for any revolutionary method of producing motor fuels. However, the situation takes on a different aspect when one is familiar with the other great developments which have led up to the present state of affairs.

When the oil industry was very young, there was a well-distributed demand for all of the important products of petroleum. Then the market for illuminating oil stepped ahead of the others. While meeting the demand for kerosene, the refiners found that something had to be done about disposing of the rest of the products.

The solution was found in a new process, by "cracking" the heavier fractions of the crude oils in such a way that a larger proportion of kerosene was obtained. Crude oils which normally yielded 20 to 30 percent of kerosene were made to yield from 50 to 70 percent by this revolutionary step.



The retorts (inside the concrete structure) in which the hydrogenation takes place at Bayway

SOME time later, the situation took a new turn. Gasoline became the most valuable fraction, and the demand for kerosene declined. Again something had to be done about utilizing the less valuable products, and again the solution was found in improving the process. It proved to be considerably more difficult to increase the gasoline yield, but the result was nearly as good as when effecting the decomposition into kerosene fractions. At the present time about one third of the world's total demand for gasoline is met by "cracking" or conversion, rather than by refining.

With this background, it is easy to see where hydrogenation fits into the picture. With the ever-growing demand for gasoline and light oils, there has been constant over-production of the less valuable products, the heavy oils. The market has shown that it does little good to lower the price of this class of fuel. There simply is little demand for it.

Careful examination of the cracking process does not give any grounds for presuming that the problem can be met by an improvement in technique with the present production methods. Attempts are being made to perfect the Diesel engine to so great an extent that it will operate satisfactorily on the inferior grades of fuel oil, as it now does on the better grades. Research in both of these fields is yielding some very commendable progress, but there seems to be no justification for high hopes. Meanwhile, the world has an enormous over-supply of heavy fuel, and the market for the more valuable motor fuels has not yet neared the limit of its elasticity.

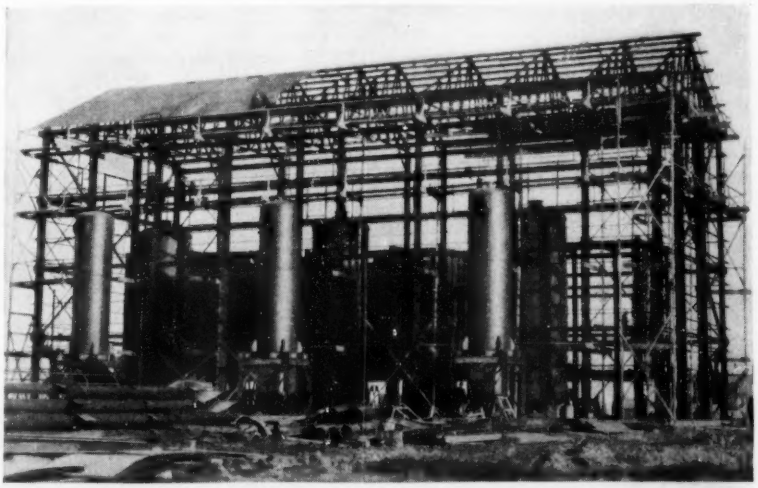
From this it is clear that there is need for a new manufacturing process which can make profitable use of the petroleum products which now are a drug on the market. The hydrogenation process, in its present state of development, is more than capable of meeting this need. This process has shown its ability to do greater things than convert heavy oils into gasoline.

Dr. Bergius took several steps at once when he worked out a method for converting wood into gasoline. First he duplicated nature's "incoaling" process, by which he quickly transformed wood or other vegetable matter into coal. Then he went on with the same process, converting the artificial coal into oil. It was found that the same thing could be done with natural bituminous coal. The hydrogenation of heavy oils into gasoline and light oils is but a page in the story of Dr. Bergius' achievements.

After enumerating that remarkable series of advances, the writer scarcely dares mention Dr. Bergius' one great purpose, an unfinished performance which may yet make these others seem like mere side-shows. Underlying all of his research is the greatest objective of all—to perfect a practical process which will enable man to make his own food, and food for his animals, by utilizing apparently worthless materials which now are burned as rubbish.

RETURNING to today, after this glimpse of the day-after-tomorrow, we can look more deeply into the process which now is being used to produce gasoline from almost worthless heavy oils. Of paramount importance in this conversion process are the toxin-proof catalysts. These make it possible for the gaseous hydrogen, which is introduced into the high-temperature conversion apparatus under exceedingly high pressures, to transform the molecules of the heavy oils into molecules of gasoline and other light fractions.

It might be well to add a word of explanation about catalysts, for the benefit of those who find the term an unfamiliar one. In chemistry, a substance which serves the useful purpose of stimulating or facilitating a reaction, without adding to or detracting from the



Where the hydrogen will be manufactured—the gas plant building under construction. The new process consists essentially in adding hydrogen to the oil

materials involved, is known as a catalyst. In matrimony, a person who plays a similar rôle is known as a matchmaker. In both instances, they may be very helpful.

Years ago, Dr. Bergius effected the conversion of wood into coal, at a temperature of about 340 degrees, in the presence of water in liquid form. A pressure of about 200 atmospheres was provided as a means of keeping the water from vaporizing at such high temperatures. The water served to prevent super-heating of the newly-made coal, and made it possible to control the physical conditions during all phases of the incoaling reaction.

In his coal liquefaction process, Dr. Bergius used ferric oxide with the hydrogen, in apparatus designed to withstand pressures up to 2000 pounds per square inch. At a temperature of 400 to 500 degrees, Centigrade, under a pressure of about 150 atmospheres, the conversion into oil and gasoline took place. The catalysts now used with the Bergius process, as it has been improved for the commercial production of gasoline and light oils, are considered a secret. There also is great secrecy about the exact temperatures and pressures used, and other features such as the design of the high-pressure conversion apparatus.

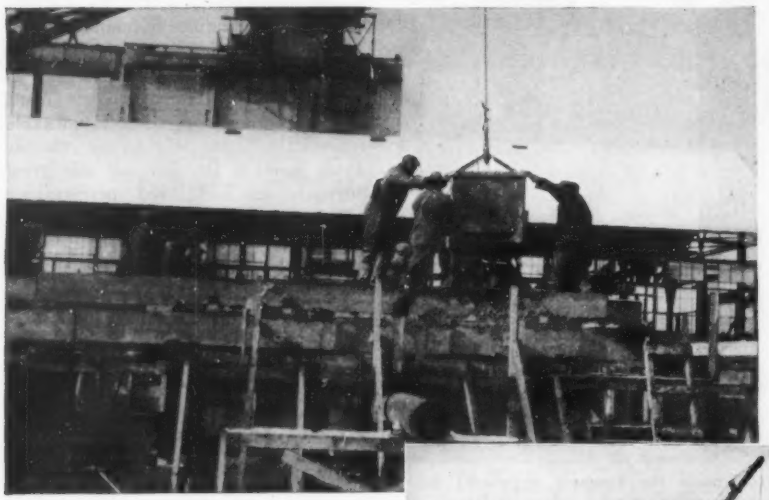
OTHER investigators, Satatier and Senderens, had found that a nickel catalyst aids in the production of methane gas from coal. The Fischer process of hydrogenation produces benzine by using iron and cobalt as the catalytic agents, and high pressure is not required. In this instance, the catalysts tend to inhibit the formation of methane, and when caustic alkalis are added the conversion continues on down to solid paraffins.

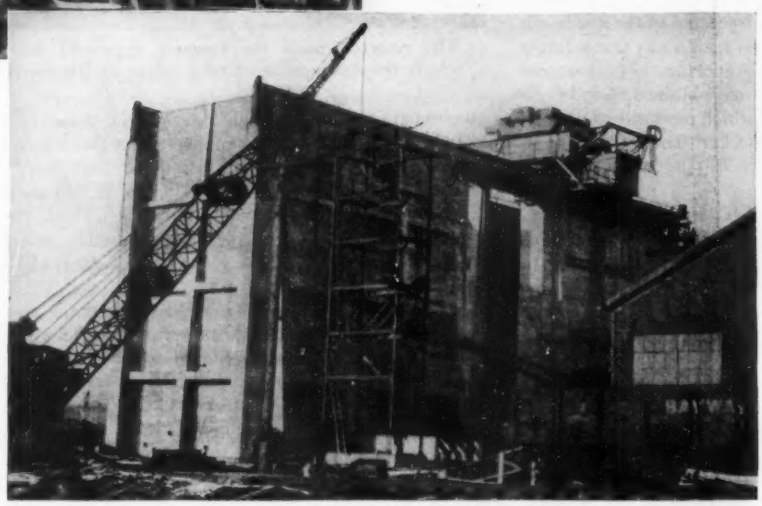
The Bergius process now is being adapted for the conversion of gasoline from heavy crude oils, such as that produced in Venezuela. By present methods of refining and cracking, only a small proportion of gasoline can be extracted from these heavy crudes. Most of the residue is heavy fuel oil, for which there is practically no demand at present.

In the hands of almost any other industrial organization, it might reasonably be feared that the exploitation of the hydrogenation process would bring about chaos in the petroleum industry. However, because of the Standard Oil Company's enormous investment in the oil industry, it is felt that the owners of the hydrogenation process will move with extreme care in order to avoid changing the *status quo* to any great extent.

The rights to use the new process in the United States will be leased to other oil companies. Licensing companies will purchase stock in the Hydro Patents Company, a subsidiary of the Standard-I. G. Company, at the rate of one share of stock for each barrel of daily hydrogenation capacity. For example, a firm desiring to establish a plant to produce gasoline at the rate of 20,000 barrels a day will buy 20,000 shares of stock in the Hydro Patents Company.

These outside firms also will be required to align themselves with another subsidiary corporation, the Hydro Engineering and Chemical Company. This organization will furnish the technical information and will supply the catalytic agents. It also will act as engineer in designing, constructing, and supervising the plants of licensees.



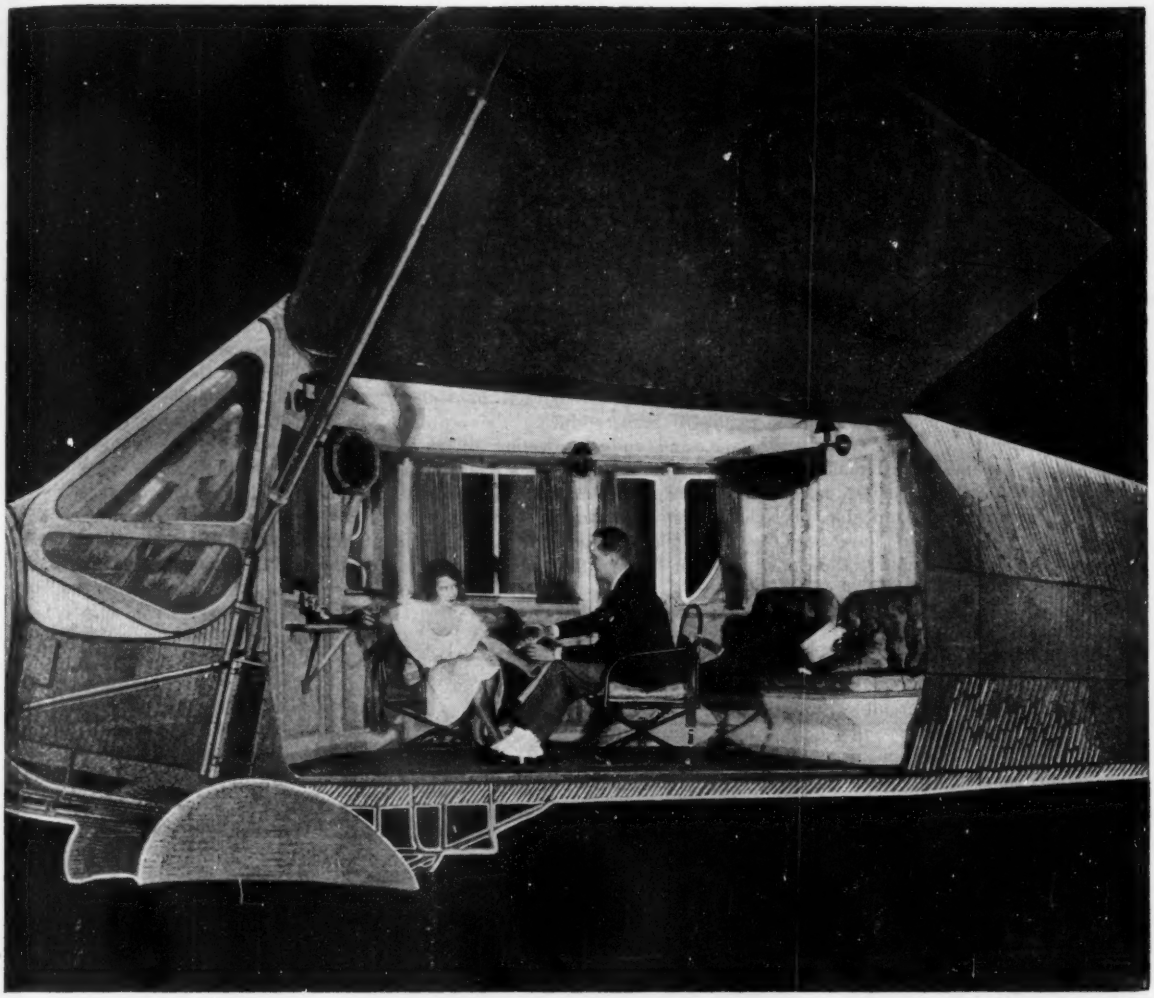


Upper: **Pouring some of the 4700 cubic yards of concrete that went into the Bayway hydro plant.** ***Lower:*** **Huge concrete slabs enclosing the reaction towers in which hydrogenation actually takes place. Overhead is a traveling crane**

ACCORDING to Mr. W. C. Teagle, president of the Standard Oil Company of New Jersey, the future of the oil industry will be determined by the extent to which both producers and refiners recognize that it is not a question of the volume of the products which governs their destiny. It must be realized that the real test is in the industry's ability to measure production to fit the requirements of the consuming markets. The probable effect of hydrogenation upon the petroleum industry is best expressed in Mr. Teagle's own words:

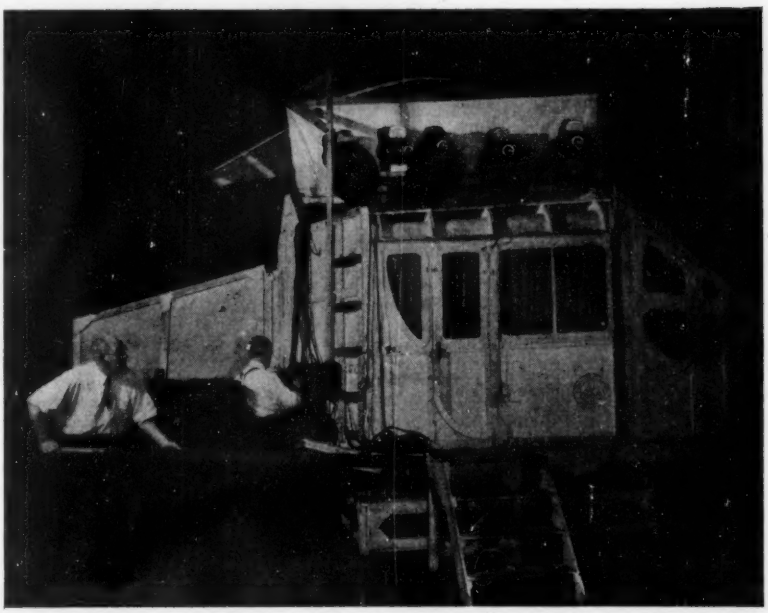
"Through hydrogenation it now is shown to be practicable to convert coal into liquid hydrocarbons at a cost which, although above prevailing oil prices, is not prohibitive. Thus, the coal reserves of the world become supplemental to the crude oil reserves.

"Because of the innumerable new technical problems, solutions of which are required for the practical and profitable use of the hydrogenation method in the oil industry, and because of the relatively large investments required, progress toward its general application will probably be slower than was the case with the cracking development. The ultimate effect, however, should be even more important."



THE STAGE GOES "AIR-MINDED"

ANY play which goes through the hands of David Belasco is sure to be elaborately staged with a fine feeling for detail by this rare artist. His latest production, called "Dancing Partner," has a scene where the lovers are taken aloft in an airplane which cavorts around while fleeting terra firma, clouds, and the starry heavens are viewed through the cabin windows. These illusions are produced by means of projectors carried on the top of the airplane, hidden from the audience by a wing and projecting directly on to the back drop. The electrician controls these effects from the side of the airplane. The huge loudspeaker for the engine effects is located at the left behind the operator who is giving motion to the plane. Another speaker in the dummy cockpit simulates the noise of the propeller and, together with the motions of the landscape and clouds and the sliding passenger seats, serves to give realism to the scene.



EARTHQUAKES

By G. AUSTIN SCHROTER

MANY bizarre theories are prevalent in the popular mind as to the origin of earthquakes and many other unrelated phenomena have been attributed to them, yet they are quite ordinary and commonplace natural processes originating within the outer crust of the earth.

The great Japanese earthquake of 1925 was probably the greatest catastrophe of modern times, and since its advent, Japanese scientists have been among the leaders in seismic studies as well as pioneers in the science of earthquake precautionary measures. Aside from the purely geologic phase of their studies, the Japanese have inaugurated a hitherto undreamed of architectural era in which beauty and safety from crustal movements have been combined.

FOR innumerable years scientist and layman alike believed the source of all seismic activity to be in volcanic activity. Although it is quite true that many sharp local shocks owe their inception to volcanic action, in the aggregate volcanism is rather a subordinate cause of major earthquakes.

There are several types of volcanoes whose classification is dependent upon the types of their eruptions.

The quiescent type, of which Mauna Loa and Kilauea in Hawaii are typical examples, completely lack the catastrophic phenomena of the volcanoes mentioned below. The quiet types give rise to outflows of intensely hot lava, without violent projection of gases or solid material; much as a pot of mush will quietly overflow its container and run down upon the stove top. Quite frequently the pent-up lava content will break through the sides of the vent and peacefully roll down the sides of the volcano until it comes to rest on the slopes below. This type of volcano is of relatively slight importance from the seismic standpoint.

The intermediate (Vesuvius) type of volcano stands midway between the quiet and explosive varieties, and quiet outpourings of lava may be preceded by or alternate with periods of violent explosive activity. This is by far the most common type of volcano, and although local tremors may have their birth in this type of eruption, they usually are of unimportant magnitude.

The explosive type of volcano is, as the name implies, marked by violent explosive activity during the eruptive stage, and sudden ejection of gases, dust, and rock fragments is typical. The most outstanding example is Krakatoa, located in the Straits of Sunda near Java. In the eruption of 1883, Schuchert says that "after premonitory outrushes of gas for some time, the great explosion occurred which blew away over a cubic mile of material from the volcano! The vast cloud of ejected material arose over 17 miles into the atmosphere, completely hiding the sun . . . over a vast area. The noise of the detonation could be heard for over 150 miles, and the atmospheric disturbance affected barometers all over the world!"

All photos by R. C. Bowes

A fault showing at a road cut. The black lines were drawn in, as the materials were poorly distinguishable in the photograph. They delimit the zone of crushed, ground-up granite. Note the uncrushed pendant within the crushed zone

Small wonder then, that some violent volcanic outbursts give rise to sharp, disastrous, local shocks. These may be due to the effect of the actual detonation on the surrounding rocks, or they may be due to collapse of the crust due to extravasation of underlying lava, just as a building will be weakened and finally collapse if the foundations are gradually removed. Still another explanation of earth tremors in connection with volcanic activity is the sudden violent shattering of hot rock in contact with steam or cold water. This process is similar to the old trick of shattering rocks by heating them in a fire and suddenly quenching them in water. There is little or no proof for this theory of rock-bursts.

IN the year 1811, the lower Mississippi valley was visited by a series of shocks, many of them catastrophic in magnitude. New Madrid in southern Missouri was demolished, and this earthquake was named after the town. Much of this region is an area of limestone rocks which are relatively soluble in circulating ground waters, as indicated by the many limestone caves which abound in the region. It has been suggested that one of the contributory causes to the New Madrid earthquake may have been the sudden collapse of the roofs of certain of these caverns due to the weight of overlying rock masses. It is, however, obvious that other factors must have entered into the case as the shocks were too heavy and too widespread to have originated in this manner alone.

This leads us to a consideration of the most outstanding and common cause for earthquakes, especially of the more sudden, heavy, and frequently disastrous shocks.

That the outer crust of our old earth is constantly undergoing alteration and modification is a fact patent to the most unskilled of observers. The mighty forces of nature seem to be forever in a state of unrest, and they are constantly

at work in their task of altering, shifting, and disintegrating the strongest of rocks and the mightiest of mountain ranges.

The sea reaches eager fingers to the land, and the sea waves with their burden of sand and littoral material wear away the land, under-cutting the strongest of cliffs, and piling the waste material in spits and bars. Tiny drops of rain fall upon the earth and, as each follows the path to the sea, does its finite bit in wearing and transporting the small products of rock decay. Rills, rivulets, and rivers scour their channels and sweep away portions of the banks, ultimately to deposit their load of silt and sand in the ocean or on some lower flood plain. Winds loaded with dust and sand abrade the toughest of rocks and carry the products of the disintegration many hundreds of miles before they are dropped. Glaciers pluck away whole mountains and move them away. Thus, even the mighty continents themselves are in motion! Throughout the vistas of geologic time mountain chains are worn away and new ones are thrown up to take their places. All of nature is at work in the age-old processes of tearing down and building up.

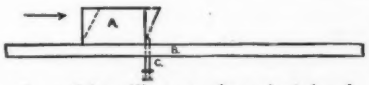
AN attempt to discuss the details of the stupendous forces of mountain making or of the uplift and subsidence of land masses, would require much space, but it becomes increasingly obvious that, when millions of tons or hundreds of thousands of cubic miles of rock are moved from one portion of the earth's crust and deposited upon another portion, adjustment of the crust must ensue to support the gigantic loads thrust upon it.

Every beam, bulwark, or foundation must have an ultimate breaking point when the loads upon it exceed its strength. And so we find that the crust of the earth must give way in places when the load placed upon it exceeds its strength. In short, a rupture or break is bound to occur, and the broken segments in turn will adjust themselves to the stresses which are acting upon them. Such ruptures or fractures in the outer crust along which appreciable movement has occurred are "faults," and it is to them that we must turn in looking for the most common cause of earthquakes.

Proof that the great crustal blocks do readjust themselves to the loads thrust upon them is apparent on every hand. Sea shells and the remains of marine organisms are found on the highest mountains, thousands of feet above sea level, old marine strand lines and beaches are elevated far above the reach of the nearest sea waves. Man-made monuments and temples that were constructed within historical times on perfectly dry land are now found to have sunk beneath the sea and been resurrected, not once, but many times. It does not seem so strange, then, that proofs of this constant crustal unrest frequently manifest themselves as shocks, tremors, and ghostly sounds, apparently arising from the very bowels of the earth.

Movements along faults are constantly in progress. No one region is free from them, and if they happen to occur suddenly or with much friction, they are manifested to our senses, but if the slip be slight or gradual, only the most sensitive of seismographs can detect it.

No hour in the day, no day in the year, and no region on earth is free from earthquakes. They are as common as life itself, but by far the largest number are not apparent to the senses. The idea that any given region is free from earthquake danger is fallacious. In New England, for example, in the 230 years following its settlement, Schuchert says that over 230 earthquakes have occurred.



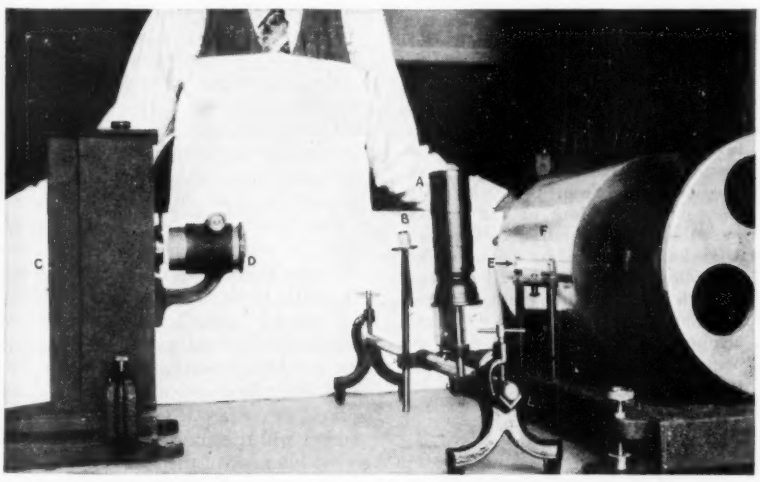
A model to illustrate the principle of elastic rebound. An India rubber block (A) sliding over a table top (B) is impeded by an upward projecting nail (C) until it tends to undergo elastic distortion. If the nail is quickly removed while the force is in operation, the elastic properties of the cube will cause it to snap into its original undistorted shape, causing an "earthquake"

Displacement along faults may be horizontal, vertical, or both vertical and horizontal, the latter being the most common type of movement. One of the most recent theories to be held regarding the origin of earthquakes is known as "Reid's theory of elastic rebound," and it may be explained somewhat as follows.

SUPPOSE that a block of India rubber is moved over a table top, as shown in the figure, until the bottom of the block is intercepted in its movement by a nail or peg driven up through the table. If the moving force continues to act, the top of the block will continue to move forward, but the bottom of the block, by virtue of the obstruction will cease to move. As a result, the elasticity of the rubber block will tend to snap it back to its original undistorted position when the obstruction is removed, and the block will assume its former shape and gliding motion with a sudden snap due to the molecular forces within it.

This process is exactly what may occur in two contiguous blocks of the earth's crust. If they are slowly moving past each other due to the stresses of readjustment, and the movement is impeded by a force tending to stop it, stresses will immediately be set up in the two blocks. The stresses will continue to grow until the moving force or the elastic tendency of the blocks overcomes them, or the rock shatters.

When either of these two phenomena occurs, it will manifest itself by a sudden sharp jar or shock, the intensity of which will depend upon the amount of deformation overcome, and upon the in-



Torsion seismograph perfected by Dr. J. A. Anderson of the Mount Wilson Observatory staff, and Dr. H. O. Wood, Research Associate of the Carnegie Seismological Laboratory at Pasadena, California. A beam of light is sent from the lamp (A) to the prism (B) from whence it is refracted to the mirror of the seismometer within the case (C). The rotating mirror of the seismometer reflects it through the telescopic attachment (D), thence through the cylindrical lens (E) to a strip of light-sensitive paper mounted on the revolving drum (F). The entire apparatus is mounted on a concrete pier within a light-proof cabinet. The optical recording system does away with many difficulties encountered in a mechanical one

tensity of the moving force. The jar will be transmitted instantly to the surrounding crust and waves will be sent out from the point of origin. These are the earthquake waves, and their physical characteristics will determine the amount of damage which they are able to do.

Some faults, quite naturally, are undergoing no movement at present, and are known as "dead-faults." Those which are at present undergoing readjustment are "live-faults." Likewise, some faults are undergoing more rapid readjustment, or are subject to greater stresses, and hence are more pregnant sources of violent shocks.

The great San Andreas rift of California has been studied more in detail, probably, than any other earthquake fault in the world. It has been traced for over 600 miles and forms the boundary between two great crustal blocks, one moving south and the other north relative to each other. It was the San Andreas rift which was the source of the California quake of 1906. In connection with this temblor, it underwent displacement for over 290 miles. Fences and roads crossing it were observed to have been broken and moved apart as much as 20 feet.

MANY earthquakes are due to vertical movement along the source-fault. For example, the great Mino-Owari earthquake in Japan showed a vertical displacement of 20 feet in one place, while the Owens Valley earthquake showed a maximum uplift of 23 feet.

Awe inspiring stories without number have been related by the survivors of great earthquakes, of the fearful sounds accompanying the shock, which were scarcely less terrifying than the quake itself. Tales of unbelievable groaning and grinding noises, of whole forests obliterated, of new streams and waterfalls formed where none before existed, of gaping fissures and dried-up wells, are commonplace and, stranger still, in the aggregate they are true.

For purposes of study, most of the sounds accompanying an earthquake are referred to the Davison sound scale, which is given below:

(1) Sounds resembling wagons, carriages, engines, or trains passing, generally very rapidly, on hard ground, over a bridge, or through a tunnel; the dragging of heavy boxes over the floor.

(2) Thunder; a loud clap or heavy peal, but most often distant thunder.

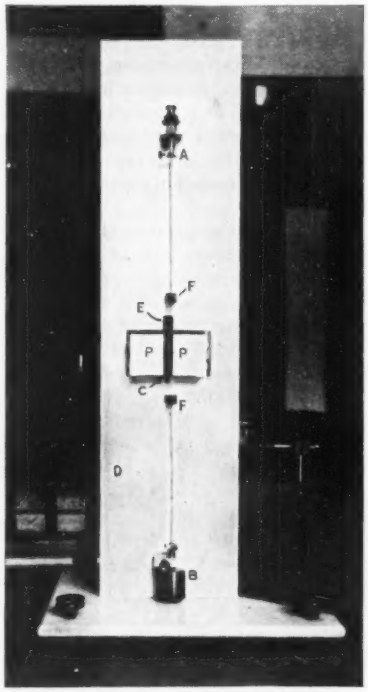
(3) Sounds resembling a moaning, roaring, rough, strong wind, a rising wind, or a heavy wind pressure against the house, a chimney on fire, and so on.

(4) Sounds of great loads of brick, coal, or rock being dumped.

(5) The fall of heavy bodies, banging of a door, pounding of the surf on the shore.

(6) Distant blasting, explosives, firing of artillery.

(7) Miscellaneous sounds such as the roaring of a waterfall, rending or tearing sounds, or the sounds of an immense covey of partridges on the wing.



Enlarged model of the torsion seismometer. A fine tungsten wire is suspended from the screw clamp (A) to the tension attachment (B). A copper cylinder (C) is mounted eccentrically on the wire. When the standard (D) vibrates, the cylinder, due to its inertia, tends to remain at rest. Torsion is set up in the wire causing rotation of the tiny mirror (E) about the suspension. A beam of light can be reflected from the mirror to a sensitized paper on a revolving drum, thus obtaining a photographic record of the shock. A magnetic field from the poles (P) damps the vibrations of the torsion pendulum. The vibration of the wire as a whole is damped by the reservoirs (F) filled with castor oil. This instrument is for use with the horizontal components of the waves. The vertical components are measured in the Carnegie Seismological Laboratory at present, on a seismometer perfected by Mr. Hugo Benioff, Research Associate

The different sounds of the Davison sound scale vary, of course, with the distance of the observer from the source of the earthquake. They may resemble the roar of a train through a tunnel in one place and the low moaning of wind in another. They may be audible to one person and entirely inaudible to another, depending upon the individual's sense of hearing. The author has many times detected the sound of thunder or heavy explosive blasts in connection with seismic activity.

The most outstanding characteristic of these seismic sounds is their extreme lowness or depth of tone, which helps to explain why they may be difficult for some persons to hear. The accompanying sounds owe their origin, of course, to the vibrations set up in the rock by the quake, just as an organ reed vibrates and causes different sounds by different intensities of vibration.

So-called "tidal waves" are another phenomenon accompanying earthquakes, especially in those of submarine origin. These waves have no relation to the tides, but are caused by the elastic rebound of submarine rock masses. In strong submarine earthquakes, the effect on ships is much as though they have struck on a rock or grated over a reef. Seismologists call these vast sea-waves *tsunamis*, from the Japanese, or when they are observed in bays or inlets, as *seiches*, especially when they are stationary waves. They may be as much as 100 or 200 miles from crest to crest, 40 feet high at the point of origin, and they may sweep across the seas with a speed of from 300 to 500 miles per hour. Such *tsunamis* may be unperceived in the open ocean, but upon reaching the land they may pile up as great waves and sweep far inland with great loss of life. Such were the waves that played havoc with Lisbon in 1755, Japan in 1854, and Peru in 1868.

EARTHQUAKES may dislodge loose masses of earth or rock, cause landslides or avalanches, and thus completely denude forest slopes, or dam streams and rivers giving rise to new lakes and "sag-ponds."

The study of earthquakes and earthquake phenomena is seismology, the instruments that are used for detecting and recording earthquakes are seismometers and seismographs, and the record obtained of an earthquake with a seismograph is a seismogram.

The principle of the seismograph is relatively simple. The instrument consists of a heavy mass of metal which by its inertia tends to remain at rest while the ground beneath it vibrates. If a pointer is fastened to the inert mass, and a calibrated drum which will move with the vibrations of the ground is rotated in contact with the pointer, the pointer will leave a record on the drum of the intensity of the shock, and of the frequency, amplitude, and period of the accompanying waves.

The classic example of the seismograph, and at the same time, one which is easily constructed, is a heavy steel ball or bearing placed on a smoked glass plate. If a shock occurs, the ball will tend to remain at rest while the glass plate under it will vibrate to and

fro, and a record of the "quake-tracks" will be left on the soot.

The ideal seismograph should be able to record the wave motions in three dimensions; that is, north-south, east-west, and up and down. So far, no such ideal instrument has been devised and in practice it is necessary, if accurate results are required, to use two types of instruments, one for vertical, the other for horizontal components.

The movements of the ground during an earthquake shock may be of two kinds: (1) in large earthquakes, there may be a sudden, large displacement, or a violent lurch of the crust, either horizontal or vertical, or in both planes, or (2) as in all earthquakes, there is a vibratory motion of the ground. The measurement of the former, the great lurches or sudden displacements, can not be accomplished by seismographs. When they take place the ordinary seismographs are thrown out of action or damaged. For recording the vibratory movements, the latter, it is necessary to have two sets of seismographs, one for near, and the other for distant, shocks.

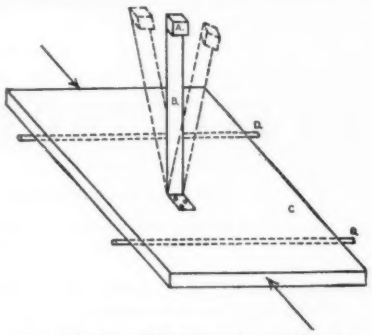
A STUDY of seismograms has indicated that the main shock is preceded by smaller, so-called "fore-shocks," and followed by slighter "after-shocks." The fore-shocks are due to the waves which have taken the shortest path from the source of the temblor to the instrument *through* the earth. The waves of the main shock are those which have traveled *around* the periphery of the earth. After-shocks are usually the result of final readjustment to stresses along the fault. In the Italian earthquake of July 23, 1930, the after-shocks continued for several days after the main, destructive shocks, and did much damage to buildings already weakened.

If three or more stations accurately record the shock, it is a fairly easy matter to calculate the origin of the earthquake. The greatest difficulty is to record the exact time of arrival of the quake at any one station so that the relative time may be determined.

The Seismological Laboratory of the Carnegie Institution of Washington, which is situated at Pasadena, California, is connected with a network of seven recording sub-stations located at Tinemaha, Haiwee, Santa Barbara, Riverside, Pasadena, Mount Wilson, and La Jolla, California. The time of arrival of a wave at any station is co-ordinated with the other stations by means of a dot-dash radiogram from a powerful, long wave, radio station. Thus, if a wave arrives at Pasadena at the beginning of a dash, and at Santa Barbara at the end of a dash, the relative time of arrival between the two stations can be calculated, and the ultimate source of the quake located.

Although, as has been mentioned, no locality is free of earthquakes, certain regions are more liable to dangerous tremors than others. These large well-defined tracts are known as seismic belts. One of them borders the Pacific Ocean, and follows the west coast of South and North America, Alaska, the Aleutian Islands, and the islands off the coast of eastern Asia. The other seismic belt borders the Mediterranean, the Alps, the Caucasus, Himalayas, and so into the East Indies.

The seismic belts follow in general the great zones of weakness in the crust of the earth. For example, off the west coast of the Americas the land is rising with respect to the ocean floor. In regions of active mountain making, great river deltas, rising or subsiding land tracts, and so on, the danger of heavy shock is more imminent.



A model to illustrate the motion in tall buildings or high stacks. The heavy metal bob (A) is mounted on the flexible brass pendulum (B) which in turn is screwed to the base (C). The base is free to roll over the rollers (D). A slight back-and-forth motion of the base will cause the pendulum to swing through a constantly growing arc

In accordance with what has been said regarding the origins of earthquakes, it would seem that in a region where many recurrent slight shocks are prevalent or common the danger of heavy damaging shocks is less. Conversely, in regions of seismic activity, periods of long quiescence may be the forerunners of a violent earthquake.

To the American people, perhaps the most horrific example of an earthquake in the rôle of a destroyer was the great California earthquake of 1906, which resulted in untold suffering, property loss, and a casualty list of close to 1000 lives. The city of San Francisco suffered the greatest loss, due in large part to the destructive fire which swept unchecked over the city following the quake, owing to destruction of pipe-lines by the tremors.

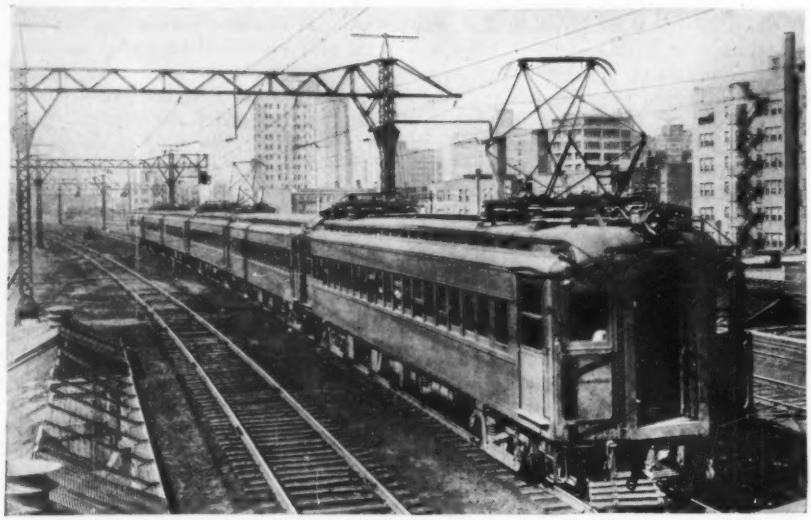
On the 28th of December, 1908, the two cities of Reggio and Messina in southern Italy, were completely destroyed with a loss of life of approximately 200,000 souls. The more recent Italian earthquake of July 23, 1930, probably had its inception in the same region, which is an active seismic one, and had the proper precautionary measures been observed, the loss of life in both of these disasters would have been very greatly reduced. In general, the least risky part of the earthquake cycle is the period after a quake; while the stresses once more accumulate after several years. Yet, such is human nature, much attention is given to precautionary measures at the former part of the cycle, but the least at the later time of increasing risk.

THE greatest danger to the populace during an earthquake arises out of poorly constructed buildings and the tendency to become panicky. By referring to the accompanying figure, the danger to be expected from very high buildings becomes obvious. A high building during a shock may act as an inverted pendulum, so that a very slight oscillation of the ground will be greatly amplified in the upper portions of the structure. Notice a clock pendulum at the point of support. The arc through which it swings is slight. At the bob, however, the arc of swing is greatly amplified, and it is in this principle that the danger from high buildings lies.

In an active seismic region the heights of buildings should be, and frequently are, limited. The danger from falling cornices, high smoke stacks, and perched water tanks can not be stressed too much. In a metropolitan district, it is far safer to run into a Class A building than into the street during a tremor, as the greatest danger lies in falling objects rather than in collapse of walls. Buildings on filled or made ground, likewise are in more danger of collapse than similar buildings built on bed rock.

Movements are now under way, in many of the larger cities, to pass ordinances requiring that buildings be designed to withstand horizontal stresses as great as the stresses upon their foundations. Large buildings, dams, and similar structures should never be built over or close to a live fault, as the danger is imminent. Brick buildings, unless highly reinforced, should be avoided in active seismic regions.

The science of seismology is still in its infancy, so that it is difficult to predict just what strides in earthquake prognostication will be made within the next few years. It is certain, however, that at present, no person can predict the time of occurrence of an earthquake in advance. The old superstitions that earthquakes are more apt to occur during the summer in preference to other seasons, or that they are preceded by "earthquake-weather," is so much rubbish. No good can ever come of such fallacies. They should be relegated to oblivion with the old superstitions of witchcraft and astrology.



Multiple unit cars in service on the Illinois Central in Chicago. Passenger cars of this type are widely used in suburban and urban service

RAILROAD ELECTRIFICATION

By FRANCIS H. SHEPARD

Director of Heavy Traction, Westinghouse Electric and Manufacturing Company

WIDESPREAD opinion has it that automobiles, buses, and airplanes are taking the business of the railroads and that, therefore, they are being electrified for economy's sake. Neither the postulate nor the conclusion is correct. While railroads admittedly are not now operating on a high-profit basis, there is a steady increase in freight shipments and even an increase in long-distance rail travel and far-sighted authorities are very optimistic for the future. Economy has no place in the American scheme of electrification, for the operating economy on electrified American roads is practically nil. Mr. Shepard has, in the accompanying article, given us the truth, as an expert sees it, about rail transportation, its relation to the electrification problem, and the full significance of the latter—what it means to railroads, to the investor in railroad securities (who will read between the lines), and to the country at large.—*The Editor.*

RAILROAD electrification in the United States is entering into an era of increased activity. Several of our railroads are now beginning to electrify their main lines and others are actively considering plans to the same end. The cost of projects at present actually under way exceeds a hundred million dollars, and the total for those contemplated is many times that amount.

Much the same tendency is noticeable throughout the world. All of the nations listed in the accompanying table are either extending or planning to extend their electric service, and, in addition, electrification work is under way in seven or eight other countries.

No single cause is responsible for all this interest. Electricity as a tool for moving traffic has a number of advantages, some of which may be the determining factors in one case while totally different ones may govern in another.

IN many instances, especially outside the United States and Great Britain, the fuel situation provides the underlying motive for electrification. When a nation lacks abundant supplies of first-class coal but is favored with ample waterpower or some form of low-grade fuel, the use of electricity for railroad operation not only may effect a large saving in operating expenses but means independence of coal-producing countries in times of emergency. Switzerland, which has already electrified almost half of her route mileage, furnishes a typical example of this condition, and in the same category are Austria, Brazil, Chile, Italy, Norway, Sweden, and, to a lesser degree, France and Germany.

In this country, on the other hand, where the cost of coal and oil is comparatively low, little or no operating economy would result by saving fuel through electrification; the fixed charges of the electric installation would, in general, be greater than the cost of fuel saved. In the decision to carry out one American electrification—that of the Chicago, Milwaukee & St. Paul—the use of waterpower played an influential part, but all the other installations in the United States were due to other considerations, which can be summarized as follows:

Tunnels. The original application of

IMPORTANT ELECTRIFIED RAILROADS OF THE WORLD

	Electrified Route Mileage	*Total Route Mileage*
United States	2500	251,000
Argentina	68	23,000
Australia	230	22,300
Austria	450	4370
Brazil	251	18,700
Canada	40	40,000
Chile	210	5400
Cuba	155	3800
Czechoslovakia	30	8800
France	875	33,000
Germany	975	36,000
India	150	38,000
Italy	1070	12,000
Japan	200	13,000
Morocco	150	900
Norway	115	2000
Spain	370	9700
Sweden	730	9800
Switzerland	1550	3600
South Africa	200	11,800
United Kingdom	450	24,000

electric power for main line haulage was made in 1895 by the Baltimore and Ohio Railroad for the purpose of avoiding smoke conditions in its long tunnel under the city of Baltimore. The success of this undertaking and subsequent development led to the use of electricity by the New York Central, the New Haven, and the Pennsylvania railroads for their tunnels into New York City, by the Boston & Maine for the Hoosac Tunnel, by the Grand Trunk for the St. Clair Tunnel, and other installations.

SUBURBAN and Terminal Service. The development of the electric street railway and, especially, the use of electrically-operated trains on the elevated railways of Chicago and other cities, showed that electric operation was superior to steam in many respects for heavy suburban service. Electric motor-car, or "multiple-unit," trains accelerate more rapidly and hence can make better time than steam trains, even if the maximum speeds of both are the same; on running into a terminal they can be run out again without further switching, whereas several car movements are needed to reverse a locomotive-hauled train, which not only require time but may congest the tracks outside the terminal; they can run through residential districts without seriously affecting real estate values; and, of course, they can move freely in tunnels of any length.

For these reasons, electric operation was adopted by the Long Island and the New Haven railroads in the vicinity of New York, the Pennsylvania at Philadelphia, the Illinois Central at Chicago, and the railroads around London, Paris, Melbourne, and other large cities.

Mountain Grades. Of a group using electric operation for totally different reasons, the Virginian Railroad is typical. The chief business of this road is to haul coal from West Virginia to tidewater at Norfolk, Virginia. Its line crosses the Allegheny Mountains and at one point some very heavy grades against traffic are encountered. Under steam operation, these grades formed the "neck of the bottle" for the railroad. Even with the use of the most powerful of steam locomotives, traffic slowed down here and the capacity of this portion set the limit to the entire road.

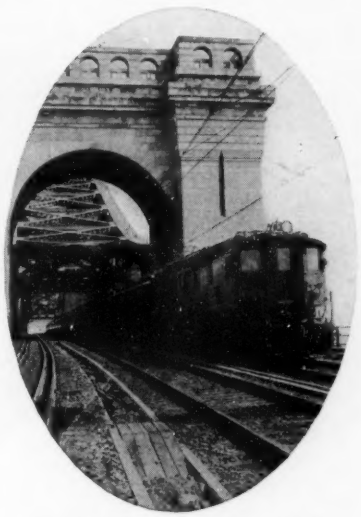
In order to increase this capacity, which was becoming more and more necessary, there were two alternatives: to retain steam operation and increase the number of tracks, or to increase the power for each train by using electricity. Owing to local conditions, the cost of additional tracks would have been exceedingly high, so electric operation was decided upon. Today, locomotives applying at times more than 20,000 horsepower per train are in use on this road, and trains are being moved up the steep grades at twice the former speed. The net result has been to increase the capacity of the road by more than 100 percent, with even greater capacity available if needed.

Other railroads using electric power for mountain-grade divisions include the Norfolk & Western and the Great Northern.

IT is obvious, however, that if these reasons alone influenced electrification in this country, we would see no general use of electric power here. The electrified areas would be confined to the great cities, the mountainous districts, and some special localities, but steam would be employed everywhere else. This, indeed, was the situation until very recently—until, in fact, the Pennsylvania Railroad announced its plans to electrify its entire system of all services from New York to Washington and as far west as the vicinity of Harrisburg, Pennsylvania.

In order to appreciate the full significance of this electrification, which is the most extensive and comprehensive one in the world, it must be considered in relation to our transportation situation as a whole.

Railroad transportation is vital to the United States. Because of it, our vast territory has been developed and our



Crossing Hell Gate Bridge on the New Haven: The Colonial Express with its 178-ton electric locomotive

people have been held together as a single nation. The moment our transportation service fails to meet our needs —as it did during and immediately following the war—everyone suffers: the price of everything we purchase and the cost of everything we produce promptly rise.

OUR demand for rail transportation far exceeds that of any other people. We require 4000 ton-miles per capita, whereas the British requirement is about 500 ton-miles. And this demand has shown marked growth: our ton-mileage for 1900 was 100,000,000,000, and today it is 440,000,000,000; and although with the present trend the aggregate is not increasing, this may be assumed to be only a temporary condition. It is true that a decrease in passenger movement has taken place recently due to the advent of the automobile, but this applies mainly to local and branch line service. On the other hand, there has been a pronounced increase of passengers traveling long distances and between populous centers. The automobile is, in fact, creating traffic by increasing the general movement of our people, by opening up areas for residence which were previously inaccessible, and by making us more travel- and speed-minded. The airplane is also acting in this same direction.

In spite of increase in the demands upon our transportation system, there has been practically no increase in the

A 6000-ton coal train on a 2 percent up grade of the Virginian Railroad, hauled by three 215-ton, 11,000 volt, single phase, Westinghouse-equipped power units

number of freight-train-miles or in the number of locomotives for the past 20 years. This means that our train units are becoming progressively heavier, and trains are being moved at higher speeds. The increase in ton-miles per hour has been nearly 50 percent in less than 10 years. The size of the locomotive has likewise grown, and the trend is conclusively toward more and more horsepower per train.

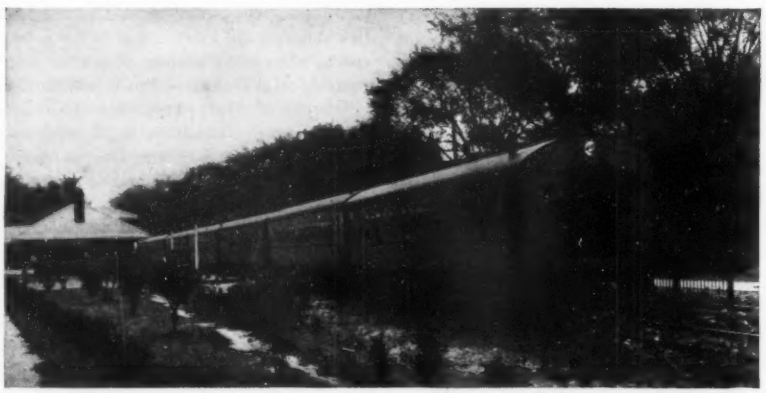
A crack silk train of the Chicago, Milwaukee, and St. Paul drawn by a 300-ton, 3000-volt direct current, Baldwin-Westinghouse electric passenger locomotive

Rail traffic, like automobile traffic, seeks those highways which are most advantageously situated. Half of our route miles carry about 90 percent of our traffic; while the great trunk lines, which constitute only about 10 percent of our route mileage, handle at least half the traffic. There is, therefore, an increasing pressure of traffic on these major routes which has been met by increasing the size and speed of the trains.

SO far, the steam locomotive, which has recently undergone conspicuous and notable development, has kept pace with our needs and will continue for many years to be the mainstay for most railroad mileage; but there may be serious question if it can meet the demands of intensive trunk-line operation after the next 20 or 30 years. Double and even treble the present movement may conceivably be the requirement.

With electric operation, on the other hand, the amount of power that can be applied to each train is practically unrestricted, and electric trains of any size can be operated at any speed within the limits set by the road-bed, draw-bars, and other mechanical equipment. Hence, an electrified railroad has greater capacity than the same road under steam power. To electrify a rail highway is to broaden it.

Behind the great electrification undertaking of the Pennsylvania Railroad, therefore, may be seen a recognition of our future transportation needs, a vision of an unhampered and ever-expanding flow of traffic, and the desire to give the public the utmost in railroad service.



Multiple unit operation in heavy duty suburban passenger service on the Long Island Railroad. This is a familiar type of car in many metropolitan localities

Important also is the inauguration by the Reading Railroad of the electrification of its lines radiating from Philadelphia; and it is understood that ultimate extensions will be made for high speed and through service. Increasing interest is also being manifested by other railroads in electrifying sections of their main lines.

Parallel to the progress in developing the utility of railroad electrification, has gone on an evolution in the kind of electric power employed. All the early systems followed street railway practice and used direct current at 500 volts supplied by a third rail. In 1902, B. G. Lamme, Chief Engineer of the Westinghouse Company, announced the results of his experimental development, sponsored by George Westinghouse, of an alternating-current motor which could operate at all the various speeds and under the different conditions required by railway service. This announcement, which indicated the possibility of serving any track with a single working conductor at any desired voltage and of supplying power to trains in any desired amount, instantaneously and effectively, aroused world-wide interest.

IN 1905, the New York, New Haven & Hartford, being governed by plans for future extension, adopted the new alternating-current system with overhead conductor at 11,000 volts. This method of operation has since been adopted and made standard by Norway, Sweden, Germany, Austria, and Switzerland, and, in this country, by the Grand Trunk St. Clair tunnel installation, the Hoosac Tunnel of the Boston & Maine, the Great Northern, Pennsylvania, Norfolk & Western, and the Virginian Railroad.

The success of the high-voltage overhead system of the New Haven stimulated the development of high-voltage direct-current equipment, and this current has been applied for various lines at 1200, 1500, 2400, and 3000 volts. Shortly after the war, the French Commission decided upon 1500 volts, direct current, as the official standard for France. The same system is in use in Japan, Java, Holland, and some other countries, while 3000 volts direct current is in use in South Africa, Chile, and Brazil, and by the Chicago, Milwaukee & St. Paul in this country.

The most extensive electrifications now being carried out in this country are with single-phase alternating current, as this system has greater promise for future advantage than any other.

ANOTHER PEKING SKULL DISCOVERED[1]

By PROFESSOR G. ELLIOT SMITH, F. R. S.

AT a meeting of the Geological Society of China in the last week of July, Prof. Davidson Black announced the discovery of another skull of Peking man.

In *Nature* of March 22, 1930[2], an account was given of the discovery of a series of remains of *Sinanthropus*, culminating in the recovery of an almost complete braincase by Mr. W. C. Pei on December 2, 1929, while clearing a sheltered recess of the main deposit at Chou Kou Tien. Some days before this skull was found, five human teeth were recovered from a spot higher up in the shaft, where they were associated with the skull of a large deer and some pieces of fossilised bone and blocks of stone, which were brought to the laboratory in Peking for examination.

This material was "developed" during the third week in June by the technical assistants working under Professor Davidson Black's supervision, and he found that there were enough fragments, which fitted together, to form the greater part of another uncrushed skull of *Sinanthropus*. He waited until the return to Peking of Dr. Wong (Wong Wen Hao), the Director of the Survey, before making the public announcement of his important discovery.

FOR reasons which are not yet clear to those who have not seen the actual specimens, Professor Davidson Black regards the skull found on December 2, 1929, as that of a young woman, and the calvaria, the discovery of which is now reported, is in his opinion that of a young adult male. It conforms to the same general type as the skull previously found, and its proportions are similar. But the braincase is not so thick and the frontal eminences not so pronounced. The most interesting new fact revealed in this discovery is the nature of the root of the nose, which is broad and flat, quite unlike that of Piltdown man.

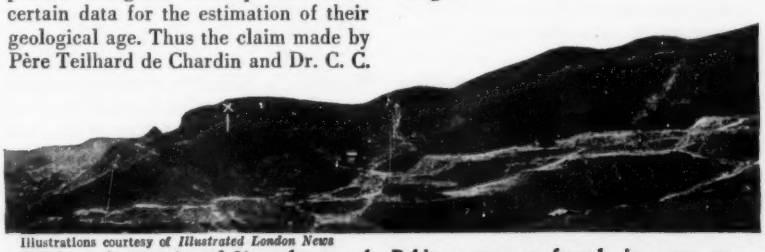
The newly discovered skull was found in association with a number of teeth which can be assumed to have belonged to the same individual. This fact adds to the interest of two mandibles found in 1928 in association with the crushed parts of the respective braincases.

The remains of four skulls of *Sinanthropus* and teeth of at least six other individuals have so far been found. Thus there is available for study in China a much richer material of early Pleistocene man than the fragments of the individual specimens of *Pithecanthropus* and *Eoanthropus* provide. Moreover, the geological age of the Chinese fossils can be established with more certainty than that of the other two primitive genera, which are assumed to be roughly contemporaneous.

The fossils from Java and Sussex were found in gravels, where they had been deposited by running water. Although there is little doubt which of the heterogeneous fossils found in these gravels were contemporaneous with the human remains, in the case of the men of Peking, who left their bones in the cave where they lived, there is less room for doubt that the bones of animals deposited alongside them provide more certain data for the estimation of their geological age. Thus the claim made by Père Teilhard de Chardin and Dr. C. C. Young that *Sinanthropus* lived in Lower Pleistocene times rests upon a surer foundation than the similar claims that have been made in the cases of *Pithecanthropus* and *Eoanthropus*.

Further, the conditions under which the discoveries are being made at Chou Kou Tien hold out a greater promise of further evidence than in the cases where the fossils have been scattered by running water. Thus a series of fragments have already been recovered every autumn since the type tooth was recovered in 1927, and it is not unreasonable to expect that much more still remains to be found in this cave, and possibly in other fossil beds in the neighborhood. So far no worked tools have been found in the cave; but if such should be recovered, their association with the human remains will be less uncertain than in the case of the other Pleistocene men's implements.

FOR these reasons, in addition to the intrinsic interest and morphological significance of the skulls of *Sinanthropus*, the discoveries in China have an importance which is unique. It is a matter for congratulation that the investigation of this site should have fallen into such competent hands and that ample facilities and skilled assistance should be available for the work, which is being conducted with great thoroughness and insight.



Illustrations courtesy of *Illustrated London News*

Where the remains of *Sinanthropus*, the Peking man, were found—in a cave on the side of a steep hill, at the spot marked X in the picture reproduced above

After a photograph by Father Teilhard de Chardin and C. C. Young

A panorama of the region around Chou Kou Tien near Peking or, as it is now called, Peiping. The small hill at left of the center (with elliptical shaded face) is the one which shows, much larger, in the upper picture which is a close-up view

[1] Reprinted from *Nature* (London) by permission.

[2] See also *Scientific American*, June and September, 1930, containing other articles on *Sinanthropus* by the author.—*The Editor.*

HOW PLUTO'S ORBIT WAS FIGURED OUT

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

NOW that the new planet has been detected upon photographs taken years ago we can be sure that we have a good idea of its orbit. But doubtless many people still are wondering why it took so long to be sure in what sort of path it was moving.

How astronomers can work out the orbit of a planet which they have been observing but a few weeks is a mystery to most people. Indeed we might go further, for even the graduate student of the science, who has gone through

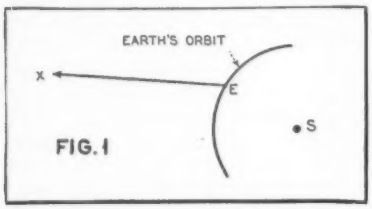


FIG. 1

the long chapter of mathematical formulae to be found in treatises on the calculation of orbits and the still longer computations which actually apply them, has often no very clear idea of the *rationale* of the complicated process. He can not see the woods for the trees.

Yet the thing is not really so hard to understand and, with due apologies to the reader whose tastes do not run along mathematical lines, let us for once consider the reader whose interests do, and try to explain as simply as possible how the apparently impossible thing is done.

FIRST of all we must realize what our planetary observations actually tell us. They give the apparent place of the body in the heavens among the stars; that is, each observation tells us very precisely in just what *direction* the planet lay from the earth (more precisely, from the particular spot on our planet where the observation was made) at an exactly specified moment. But an observation by itself tells us nothing at all about the planet's *distance*. Since the earth's motion about the sun can be accurately calculated we know just where it was at the time of observation (say at E in Figure 1). We can lay off this point on a diagram and also draw in the line EX which runs in the direction in which the planet was seen. (This line would usually run a little above or below the plane of the rest of the picture, but we may leave such details to the actual computer.)

But *where* is the planet upon this line? This is the main problem and it would be very difficult to solve if we did not know the laws according to which the planets move. Suppose that we have two observations, made at the time when the earth was at E_1 and E_2 (Figure 2). If the planet was standing still in space we could locate it at the intersection Y of the lines E_1X_1 and E_2X_2 on which it lay at these moments. But it was actually moving, and so can not have been at Y, wherever else it was.

NOW—to take a simple case first—suppose that the planet's orbit is a circle. We may then make any guess we please about its distance (say SR in Figure 2), draw a circle with this radius and find two points P_1 and P_2 at which the planet must have been if our guess was right. But *was* it right? We can test this by using Kepler's Third Law—that the squares of the periods of the planets are proportional to the cubes of their distances from the sun. We can find by measurement on our diagram, or far more accurately by calculation, what fraction the arc P_1P_2 is of the whole circumference. We know the time taken between these points and so can calculate what would be required to complete the whole orbit at this rate. If the result agrees with Kepler's law our guess was right. If not it was wrong and we try again with a new assumed distance SR′ and get two new positions P'_1 and P'_2. This time perhaps we find a motion slower than Kepler's law allows, whereas the first time it was too fast. The true value then lies between our two guesses and a few more tries will lead us step by step to the correct result.

Such calculations are often made in the case of a newly discovered asteroid to get a rough idea of its orbit and predict where it may be found a month or so later. Most of the characteristics of the general problem are well illustrated by this simple case. In the first place we see how the application of the law of motion turns an apparently hopeless problem into a very simple one. Secondly, we may note that a very small error in our observations may cause a serious one in our results. Suppose that we have got the direction of one of the lines, say E_2X_2, a little wrong. The distance P_1P_2 will then be wrong and, when we compute the time required to make the circuit of the whole orbit from that of this short arc, our error will be greatly magnified; and the same will be true of the final calculated distance. For this reason the computer must assure himself at the start that the observations which he uses have been made with skill and care before he wastes time on useless calculations.

AGAIN we may notice that our problem, as illustrated in Figure 2, admits of two solutions. Instead of starting with an assumed distance less than SY we might have adopted a greater one (SR″ in the figure). We would then have found the planet moving backward about the sun, but by the same process of trial and error we could have hit on an assumed distance at which the rate of motion would agree with Kepler's law. Two quite different planets, then, one relatively near the sun and moving forward, the other farther away and moving backward, each in a circular orbit, might both have been exactly on the observed lines at the correct dates. Later on, of course, their directions from the earth would differ and a third observation would tell which was the true answer (practically, since all of the thousand and more known planets move forward, no doubt would arise).

When the orbit is an ellipse (or a parabola or a hyperbola in the case of a comet) the problem of calculating it is much more complicated but the principles which have just been illustrated still hold good.

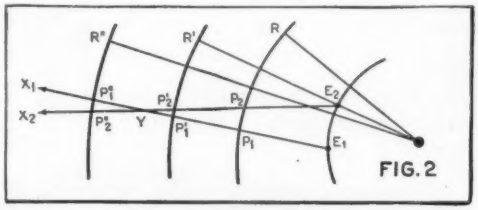


FIG. 2

In this case we must have three observations instead of two—which can be seen from very general considerations. If we have to find the values of a certain number of unknown quantities

—say six—we must have an equal number of equations (or, more generally, of known relations) from which to find them. No algebraical skill can get out the values of all six from only five independent data.

Now each observation of a planet gives us two such independent data, the right ascension and declination. To specify completely a circular orbit we require four "elements"—the node and inclination of the orbit plane, the planet's distance from the sun, and its position on the orbit at a given instant. Two complete observations giving four data to work on should therefore just suffice to work out a circular orbit; as they do. For an elliptic orbit there are two more elements to be found—the eccentricity and the longitude of perihelion, making six in all; and three observations will give us just what we need for a solution.

Once again the principal problem is to find the planet's distance. How it is done may best be explained by going back directly to the law of gravitation. We have now to take account of the fact that the orbits of the earth and the planet are in different planes both passing through the sun, as shown in Figure 3. $E_1E_2E_3$ and $P_1P_2P_3$ are the positions of the earth and planet at the three dates of observation. It is always possible to pass a plane A (the least shaded one in the figure) through the line E_1P_1 in such a way that E_3P_3 is parallel to it (though in the case represented lying higher) and E_3 and P_3 are at equal heights above the plane. Now the sun attracts both the earth and the planet, so that their orbits are curved and E_2 and P_2 lie higher than the other two points on each orbit. But since the earth is nearer the sun than the planet, the sun attracts it more strongly and curves its orbit more, so that E_2 will be farther from the one line than P_2 is from the other, and will be higher above the plane A than P_2 (the more so because the earth's orbit is more highly inclined to A than is the planet's). Hence the line E_2P_2 will not be parallel to A, but will slope downward and meet it at some point beyond P_2.

THE angle of this slope may be found from our observations, which tell us just where the three lines are—though not where the points P lie on them.

Now, making any convenient assumption about the distance E_2P_2, it is possible to calculate the influence of the sun's gravitation in curving the planet's orbit (that on the earth's is of course known) and hence to find what the slope of this line should be. Successive trials would then lead us to the correct value. When, as in practice, the arcs E_1E_3 and P_1P_3 are but small parts of the orbit it is possible to set up an algebraic equation which saves the time-consuming process of solution by trial and error and gives the desired distance directly. This equation is of the eighth degree but its solution has been made much easier by the calculation of special tables and presents no great trouble. When once the planet's distance at the time of one observation has been determined, its distances at the other two dates may be found by another equally simple application of the laws of motion under gravity (which, however, we have not space to describe in detail). To calculate the orbit about the sun is then easy enough. It may be noticed that, though the planet's orbit is drawn as an ellipse in the figure, the same reasoning would apply in the case of a hyperbolic comet. In fact the solution leads automatically to a determination of eccentricity of the orbit and the size and shape, whatever they may be.

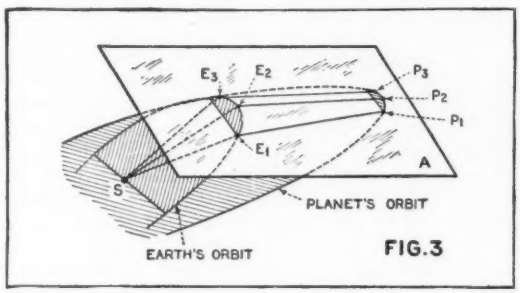


FIG.3

ONCE again a small error in any of the observations is likely to be greatly multiplied in the results of the calculation. A "first orbit" based on all three observations is therefore usually of low accuracy. It serves completely, however, for predictions good enough to keep track of the planet until, some months after the discovery, it is lost to observation in the vicinity of the sun. Then by utilizing the data obtained in this interval a better orbit can be calculated, sufficient for finding the planet next year, and sometimes, as has recently been illustrated, on old photographs; and then a still better orbit may be calculated.

The general equation for finding the planet's distance has sometimes one real solution and sometimes three, leading to three different orbits in any of which a planet could move so as to be on the three given lines at the given instants. Charlier the distinguished Swedish astronomer has, however, shown that when a body is observed near opposition there can only be one solution of the problem and this is practically always the case for planetary discoveries. For a comet observed near the sun there may be three solutions, as happened for the great daylight comets of 1843, 1882, and 1910.

For a distant body like the new planet Pluto the apparent motion is slow and the effects of even very small observational errors may be considerable until observations covering several months are available. The delay in calculations and publishing an orbit of this most interesting body is therefore good evidence of the full comprehension which its discoverers had of the problem, as well as their excellent judgment.—*Cortina d' Ampezzo, Italy.*

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EDITOR'S NOTE: In the light of Professor Russell's lucid explanation of the standard method by which astronomers work out a new orbit, some notes on Pluto's orbit, by the astronomers Ernest Clare Bower and Fred L. Whipple of Lick Observatory, published in the August number of the *Publications of the Astronomical Society of the Pacific,* make interesting reading. These astronomers state that, between last January and June, more than 100 accurate observations of the orbital arc described by Pluto were made available by various astronomers, "but," they add, "these alone would not suffice were they not augmented by observations made possible by the identification of the object on plates taken before its discovery." This was because the January-June, 1930, observations would cover only about 1/500 of the full orbit—a pretty short arc from which to work out an accurate orbit. But at this juncture Mount Wilson, Yerkes and one other observatory came to the rescue with some old plates of the vintage of 1919, 1921 and 1927, which they had found in storage. With these "pre-discovery" observations the new arc now represented a span of 11 years or about 1/25 of the whole circumference of the orbit, a respectable base line from which to perform calculations. How closely Pluto now has been pinned down is shown by the fair agreement in the following results of various astronomers' calculations:

	By Bower and Whipple	By Nicholson and Mayall
Perihelion passage due	Feb. 27.473, 1989	June 5.5, 1988
Eccentricity of the orbit	0.253741	0.2575
Inclination of the orbit	17°8′57″	17° 09′
Period of revolution	249.1661 years	251.80 years

TELEVISION NEEDS NEW IDEAS— AND LESS BALLYHOO

The author

By A. DINSDALE, Assoc. I. R. E.

EVER since I reached the hospitable shores of the United States, nearly every person I have met has asked me: "Well, how long do *you* think it will be before we get television?" I never have felt any particular urge to assume the rôle of prophet, and it seems to me that prophesying about television is about as thankless a job as that possessed by the weather forecaster.

To begin with, it depends largely upon what you mean by television and what you expect it to do. In Europe the public, educated by a vast amount of advance publicity designed to boost somebody's over-enthusiastic claims, has acquired definite and rather high standards about television. It has heard so much about being able to "see the world from your own fireside," to watch the finish of the Derby or the final of the Cup Tie (England's star football match), that it expects just that. And as nobody so far is able to provide the necessary apparatus and service, the public has become somewhat apathetic. It has metaphorically rolled over and gone off to sleep again until something startling happens to wake it up. Extensive lecture tours have shown me that there is no lack of interest on the part of the British public, but much disappointment at the non-fulfilment of promises. "Hope deferred maketh the heart sick."

IN America the position seems to be rather more complicated. In the first place, there seems to have been even more ballyhoo about television over here than there has been in Europe. There are more people working on it, some earnestly and scientifically, and some not so scientifically, some with laudable aims, and some with aims not so laudable.

Since I arrived here I have talked with most of the leading workers in the field, and I can find no unanimity as to what television must be able to do. Dr. Alexanderson, for instance, thinks that a limited form of television will be sufficient, while Dr. Ives looks to the time when television will be able to do all that the talking movie can do, and as well. He contends, however, and I think quite rightly, that the system of television as developed by the Bell Telephone Laboratories for use in conjunction with the telephone, is quite adequate for the purpose. But that is a specialized application. The public expects broadcast television.

With television workers themselves at variance as to what television must be able to do, it is not surprising that the general public has no definite notions on the subject. At least, nobody seems to be able to tell exactly what the public wants or expects. Under these circumstances, the obvious thing to do would appear to be to give the public what you have, try to educate them into liking it, and keep on improving on it.

THAT television today is up against an impasse is a fact acknowledged by most authorities, although sporadic articles in the daily press would lead the layman to believe that television is soon to be ready for general use. This impression is fostered by interesting experiments on a laboratory scale which have been heralded as forerunners of practical home televisors. But even the best television equipment available today falls far short of the desired home radio-movie goal, and it becomes increasingly apparent that new paths must be beaten before present-day mechanical and electrical difficulties are overcome. The author of the accompanying article, formerly editor of *Television* (London), presents a point of view that is refreshing after the deluge of misleading publicity of the past few years.—*The Editor.*

The general public, however, will have none of the present limited form of television, which can show only a head-and-shoulder view of some distant speaker or singer, and that imperfectly. The fans, who love tinkering with something, have taken to it, of course, both here and in Europe, but commercial sets just cannot be sold. In England, the Baird Company's attempt to sell machines has met with but scant success. They blame the limited broadcast facilities granted them by the B.B.C.: 11 to 11:30 A.M. five days a week, and midnight to 12:30 A.M. two nights a week. But over here, where broadcast facilities are available on a more liberal scale, I am told that attempts to sell inadequate televisors are meeting with no better success.

The real reason for this failure is not far to seek, and is very simple. There is definitely no entertainment value in the present head-and-shoulder images. Realizing that fact, the Germans have made no attempt as yet to sell televisors; they are devoting all their energies to further experimenting.

THERE are some who disagree with me about the entertainment value of the present image, and point to the fact that something like 75 percent of a talking film is composed of close-ups. True, but the film shows more of the individual, more than one person at a time, has a lot more detail, and the producers have had years of experience with their medium of entertainment and have learned how to make it entertain. On the latter score the television people have reached the point where they say that "a new technique will have to be developed." Nobody knows yet just what form that technique will take. And at this stage they can not be expected to know.

Others who disagree with me contend that a start must be made somewhere, sometime, and point to the crudeness of the art of radio-telephony when sound broadcasting first started. It is difficult to compare two things which are totally different, but I believe that sound broadcasting, when it started, had more power to interest, entertain, and attract than has the art of television at the present time.

Just what the public expects of television is a question nobody can answer. Some go so far as to express doubt as to whether the public wants television at all! I think there can be no doubt that, after what it has been led to expect of television, any serious attempt to stampede the public into patronizing the present limited form of television will not only meet with failure, but will do the youthful art irreparable harm. Some harm has already been done.

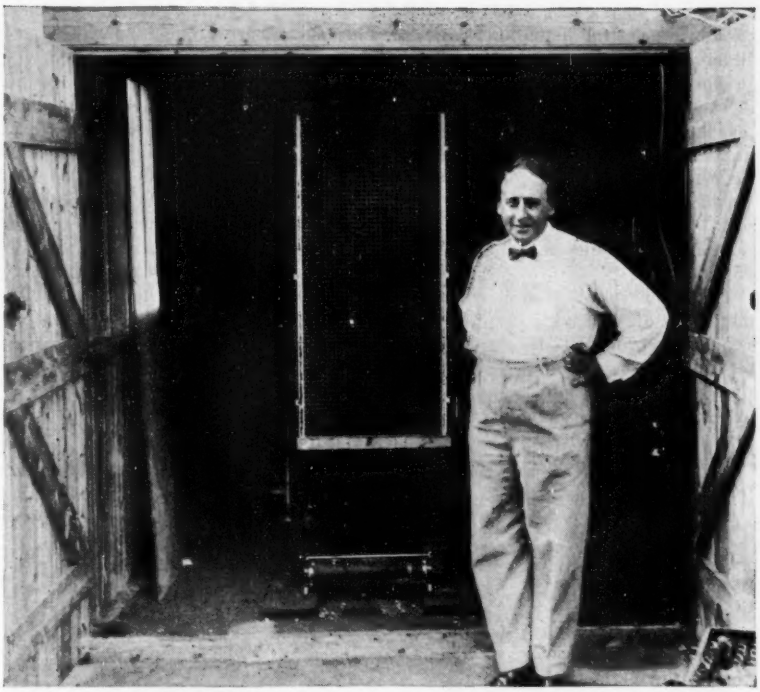
Let us, therefore, survey the present state of the art from a technical angle. Let us create a standard of performance and see if present methods will permit of its achievement.

But let me make one thing clear before I proceed further. In reading over what I have written it would appear that I am a thorough pessimist, more of an enemy than a friend to television. Far from it. There is no doubt at all in my mind that television will ultimately arrive. It will eventually be able to do all that has been promised. Televisors will one day be as common in our homes as radio sets are today, and a television industry will grow to the proportions of the present radio industry.

But before all these things can happen we shall have to think up a few new ideas.

It is an extraordinary fact that television has not, so far, developed any brand new ideas for its own exclusive use. All its ideas and apparatus are either borrowed from some other field of scientific endeavor, or they have been in existence, but not made use of, for many years.

Take the scanning disk, for example. Invented by Nipkow in 1884, it lay idle until it was coupled with such modern inventions (taken from other fields) as the neon lamp, thermionic tube, and photo-electric cell, when television was produced. Nipkow could have done it in 1884 if he had had the use of these modern facilities.



Baird's large television receiving screen. The extreme complexity of devices of this nature is an important indication of the need for new ideas in the art

THE large viewing screens of Jenkins, the Bell Telephone Laboratories, and Baird are reminiscent of the walls of selenium cells controlling distant electric bulbs, which were suggested by several early enthusiasts and actually constructed by Rignoux and Fournier in 1906.

The use of cathode-ray tubes was first suggested by Campbell Swinton in 1911, and they were experimented with soon after by Boris Rosing in Russia and Belin in France.

All these things have, of course, been vastly improved upon and made to perform incredibly well, thanks to modern facilities, but they have their limitations. What astonishes one is that all the present-known workers, knowing these limitations, are content to pursue the old methods. Some entirely new principle is needed, and needed badly. And it is quite on the cards that the present workers will get so stale and hide-bound that the new idea, when it does come along, will pop out suddenly and unexpectedly from a source never previously heard of.

Before we can proceed to an examination of the limitations of present television apparatus and methods, it is necessary to set forth some standard of achievement which must ultimately be met, and see how far toward that standard we can go with the means at present available.

My guess is that television, for home entertainment purposes, will have to be capable of embracing a field of view, either indoors or outdoors, as extensive, complete, and flexible as is at present coverable by means of a motion picture camera, and the detail presented will have to be comparable with that of the motion picture also. After all, as an entertainment medium, television must go into direct competition with the motion picture, or couple up with it so that films can be distributed and simultaneously exhibited all over the country by television methods. It will displace the film for spot news, although the film will always be wanted for record purposes.

The home screen upon which the television images are depicted will have to be, for comfort and convenience, not smaller than nine by twelve inches, unmagnified. The magnifying lenses at present in use are undesirable for several reasons. Many of them are so badly designed and arranged that they distort the edges of the picture. Even if well arranged, they magnify all the defects in the image, cause loss of light, and, perhaps most important, limit the number of observers to two or three, and force even that number to locate themselves, often in discomfort, directly in front of the lens. The standard of comfort of the home movies must prevail on this point.

Having thus set the standards of field of view and size of screen, the next important step is to fix quantitatively the amount of detail which must be provided. Here it is necessary to guess a bit again. If scanning is to continue to be carried out in parallel strips or lines, my guess is that we shall have to provide 100 lines per inch. That means that, for a nine by twelve inch receiving screen, unmagnified, we shall have to resolve the image into $900 \times 1200 = 1{,}080{,}000$ picture elements. If we set the transmission speed at 15 images per second —a rather low figure—the frequency of the A. C. picture impulses which we must transmit, either by wire or by wireless, works out at

$$\frac{1{,}080{,}000 \times 15}{2} = 8{,}100{,}000 \text{ cycles,}$$

or 8100 kilocycles.

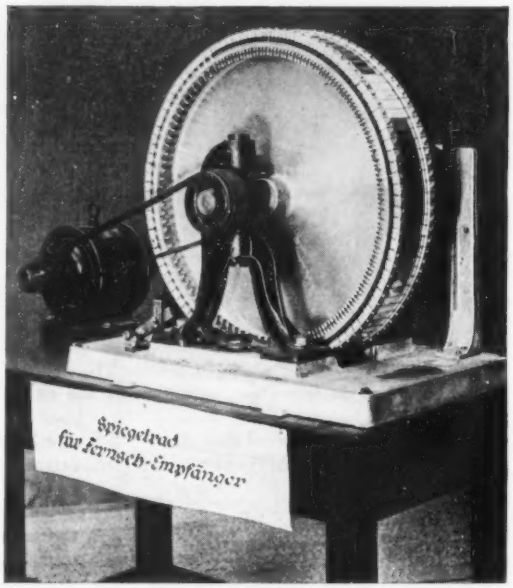
WE are now faced with two major problems: (1) terminal equipment capable of fulfilling the above requirements, and (2) channels of communication which will successfully transmit frequencies up to 8100 kilocycles.

Let us consider terminal equipment first. Remembering that the circumferential distance between the holes of a scanning disk must be equivalent to the long side of the picture, in this case twelve inches, and that there must be 900 of them, we should require a scanning disk nearly 300 feet in diameter to fulfill the requirements set out above! And if we used a flat plate neon tube, we should need one with a plate measuring slightly in excess of nine by twelve

inches, and such a tube would require a prohibitive amount of amplifier power to illuminate it. The whole conception is preposterous and ridiculous.

The Jenkins drum scanner provides no solution to the problem; it also would assume unwieldy proportions. There remains the Weiller mirror drum, which would require 900 mirrors, and if these were only one inch wide the diameter of the drum would be something like 25 feet.

That exhausts all known mechanical methods of scanning which have proved at all successful. It is obvious, therefore, that we must either relax our requirements for television or seek other and non-mechanical methods.



The Weiller mirror wheel used in television scanning. For large images, this device becomes unsatisfactory

BEFORE the days of the thermionic tube, we achieved, or attempted to achieve, radio-telegraph communication by just such cumbersome "brute force" methods. Now we have thrown all our unwieldy machinery into the discard, and achieve our object a thousand times better by harnessing electrons. We shall have to discover some method of harnessing electrons to do our bidding in the television field. A stream of electrons travels with the speed of light, it is weightless and therefore inertialess, and it can be controlled electrostatically or magnetically.

The fundamental essence of the television problem may be defined as the time element, or, if you like, speed; so much has to be done in such a limited space of time. As we have already seen, 16,200,000 picture elements have to be dealt with *per second*. Obviously, only electrons are capable of handling such a gigantic number within the time allowed.

The only electron device at present known which seems to offer a ready solution to the problem is the cathode-ray tube. It has been experimented with for many years, and several workers are still busy on it, trying to adapt it for both transmission and reception purposes. As at present made and used, the cathode-ray tube has many disadvantages. It is expensive, both as to first cost and as to auxiliary equipment and operation, its life is short, and there are still difficulties in the way of adequately controlling the scanning movements of the electron stream. It remains to be seen, therefore, whether the cathode-ray tube is the best practical embodiment of the purely electronic method of achieving television.

So much for terminal equipment.

Coming now to channels of communication, one is almost tempted to say that it will never be possible to transmit 8100 kilocycles over either a wire or a radio circuit. But in scientific matters today's impossibility is tomorrow's commonplace achievement. At present it might be possible to transmit such an enormous frequency by radio, but only on wavelengths below ten meters. Obviously we shall have to discover some new technique or principle in radio communication also. That it is already long overdue is evidenced by the fact that the entire spectrum of wavelengths used for all radio communication purposes is already full to overflowing; radio communication cannot develop any further until it is released from its strait-jacket. Personally, I think the new principle discovered by Dr. J. Robinson of England, and incorporated in the Stenode Radiostat receiver, will not only solve the overcrowding problem but also make it possible to transmit the enormously high frequencies required for television.

That is my conception of the problem of television as it stands today. A gloomy picture, you may say. Or again you may ask me: "How long will it be—?" As I said at the outset, I am not going to be inveigled into prophesying, but I feel very optimistic about the future development of television. It is clear that much remains to be done, and it is equally clear that television is going to provide yet another example of the survival of the fittest. So much remains to be done that only those who are backed by almost unlimited resources in the shape of money, brains, and laboratory facilities stand any chance of winning through and reaping their reward.

The work which has been done to date, and about which there has been so much ballyhoo, must be regarded in the light of a preliminary canter over the course. Already there is evidence that the most serious contenders in the race for television are abandoning present methods and working quietly behind locked doors on something different. In Germany, Dr. Karolus, working in conjunction with the Telefunken Company, has been silent, but not inactive, for a year.

IN this country, the television staffs of the General Electric and Westinghouse companies have just been concentrated in the R. C. A.-Victor plant at Camden, New Jersey. That the R. C. A. group really means business is evidenced by the utterances of its executives, and if further evidence is required of the imminence of television on a really commercial and entertaining scale, there is the projected 250,000,000-dollar Rockefeller radio city which Merlin Hall Aylesworth, President of the National Broadcasting Company, says is to be built around television. It is estimated that this building will be ready in three years, and that is as near as I will go to prophesying when television will be ready to make its bow to the public, not in so perfect a form as I have outlined as being ultimately necessary, but at least some way towards it.

And finally, I have been asked who will win the race, Europe or America. Well, one of the essential qualifications of the competitors, mentioned above, has to do with financial resources, and America has more money to spend on television than has Europe, and America seems to be more determined. So with that I will leave the American workers to it, and wish them the best of luck.

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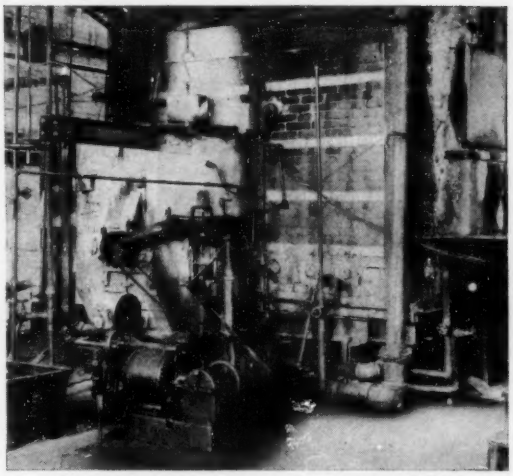
Editor's Note. Although we are in hearty accord with Mr. Dinsdale in the general tenor of the foregoing article, we can not help but take exception to the statement ending at the top of this column. There are thousands of amateurs in this country who are learning the fundamentals of television by experimenting with their own equipment. And it is well known that the radio amateur is never content to follow the beaten paths. His record in the development of the short waves justifies this statement, and we do not feel that we are too optimistic when we express the opinion that the ranks of amateur radio will contribute some of the new ideas needed for the development of television.

GLASS TUBING BY THE MILE

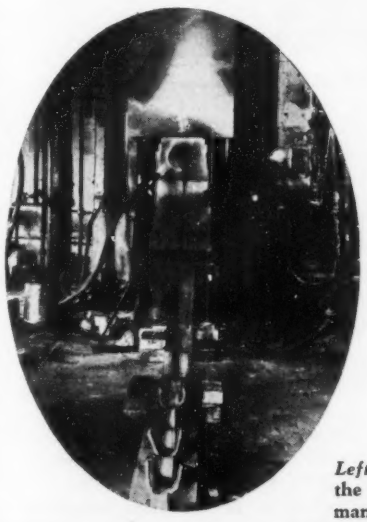
THE old method of making glass tubing by blowing, while the hollow cylinder was pulled out and cooled, was an exceedingly crude process and the variations in the size of the bore were great. Now, however, by the aid of cleverly designed machinery, although under the principles of the archaic methods, glass tubing is made by the mile. The machines operate continuously, drawing the molten glass from the furnace, cooling it at a distant point and cutting it off in pre-determined lengths, automatically, by a special mechanical device. In this method, as in the hand process, there is a long line of easily broken tubing in constant motion between the blow-pipe and the far end where the cutting operation takes place.

A tank furnace supplies a steady stream of molten glass. As the viscous glass flows to the aperture, it is kept very hot by the glass blow-pipes. The glass forms a tube over a hollow mandrel by the aid of air which is forced through it. The air pressure is slight, being only one or two ounces per square inch. If this air should be cut off, a cylinder of solid glass would form. After the tube is formed comes the drawing process which is dependent on a machine which pulls away, continuously, the rapidly cooling tubes of glass. Two endless chains serve to carry pressure plates which grip the tube without fracturing it. The motion is positive and in one direction. The cooled tube is drawn away from the furnace, dragging away more of the molten glass which is to form the tube over the hollow mandrel which purveys the air for blowing. The machine is dealing with a very peculiar substance and the slightest tendency to buckle up would fracture the tubing. The speed of the pulling chains may be adjusted at will.

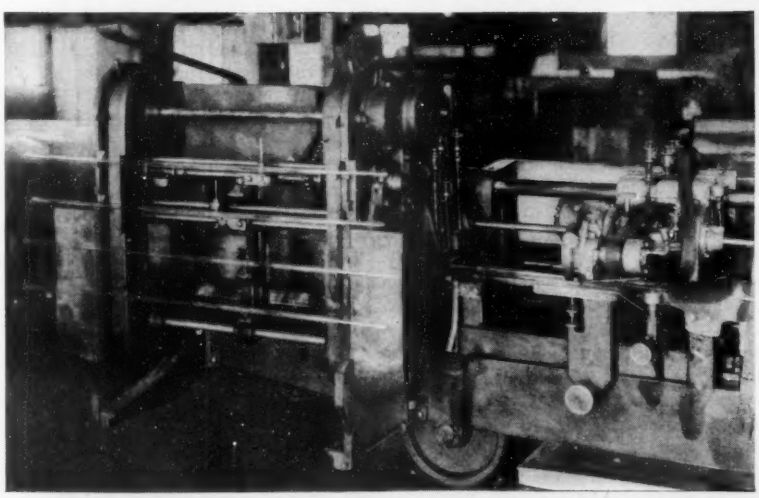


View of the rear of the glass melting furnace

The pulling machine is supplemented by a device for breaking off the tube in pre-determined lengths as it is pulled along. After the tube leaves the endless chains it encounters a second set of guide-rolls mounted on vertical spindles. Next it passes over a pressure table which yields vertically. Then it enters a part of a special wheel and is broken off to the proper length. This length is finally delivered from the machine for inspection and packing. The cutter wheel co-acts with the pressure table. That is to say, the cutter wheel moves downward and comes into contact with the work at the beginning of its own stroke. The cutter wheel cuts a surface groove on the glass. It is not designed to effect a complete severance of the glass but to make a point of weakness. A second wheel revolves intermittently and exerts a transverse pressure against the work at a point in advance of the cut, thus breaking it off at the groove. The demands for uniform glass tubing, in science and industry, are many.

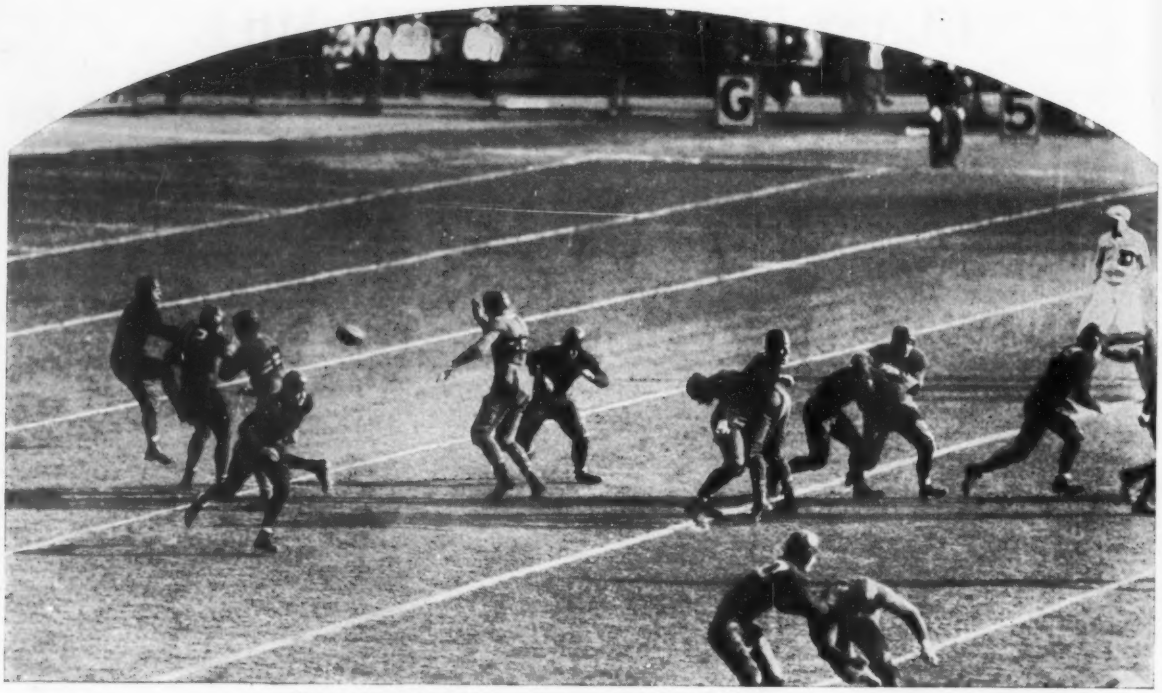


Left: Discharge end of blow pipe from which the glass is drawn. *Right:* Heater muffle and mandrel forming the continuous glass tube



After the glass tube has been drawn from the furnace with the aid of a "pulling" machine, it is cut off with this machine and the broken-off length is delivered

We are indebted to the Libbey Glass Manufacturing Company of Toledo, Ohio, for permission to inspect the interesting process.



The Army blocks a Notre Dame punt in their famous 1929 game

HOW MANY MINUTES OF PLAY IN THE AVERAGE FOOTBALL GAME?

By HUGO L. RUSCH
Supervisor Technical Data Section, Johns-Mansville Corp.

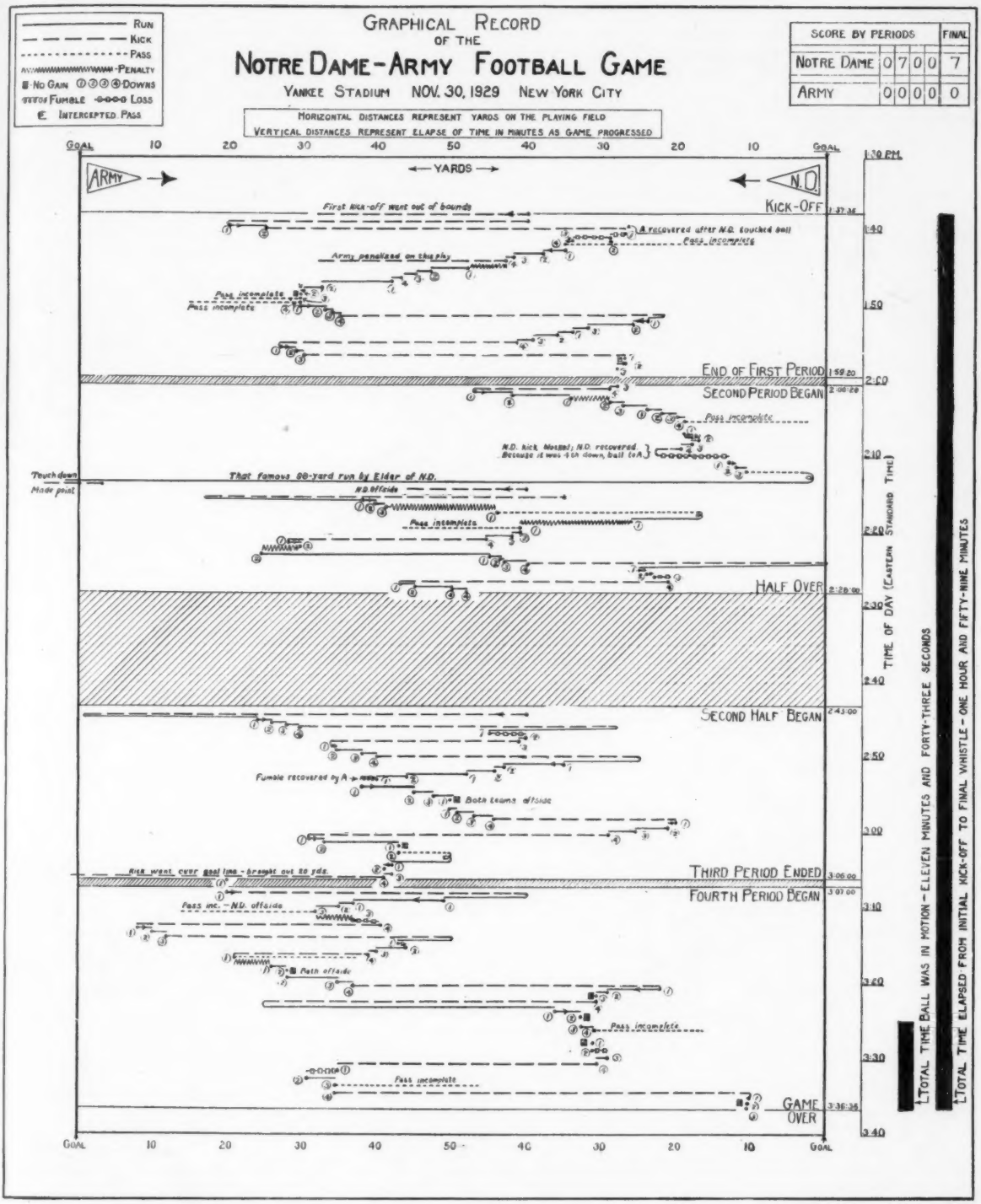
YOU pay at the rate of $24.25 per hour to watch football! It costs hundreds of thousands of spectators this amount for their amusement every autumn. The time the ball is officially in motion during an entire game—clocking each play with a stop-watch from the instant center snaps back the ball until the end of the play—totals the astoundingly short period of about 12 minutes. To be exact, the actual playing time in eight important games during the 1927, 1928, and 1929 seasons in which Notre Dame, the Army, Yale, Harvard, Princeton, Stanford, Ohio State, Columbia, Indiana, and Syracuse participated was an average of 12 minutes and 22 seconds per game. With your ticket costing you five dollars you paid at the rate of $24.25 per hour. If you were able to buy a ticket for three dollars, your hourly rate was only $14.55. If you were one of those spectators who paid sixty dollars a pair for the coveted pasteboards, figure out your own rate per hour.

The official playing time of one hour—four quarters of 15 minutes each—includes time for signals, formations, and shifts. The rest period between the first and second quarters, and the third and fourth quarters, is one minute; the time between halves is 15 minutes. Including periods for "time out," the total lapse of time from the initial kick-off to the final whistle, for the eight games mentioned, averaged 2 hours 20 minutes and 9 seconds.

TAKE the case of the Army-Notre Dame game at the Yankee Stadium on the last day of November, 1929—the game in which Elder of Notre Dame thrilled 83,000 spectators and many more thousands of radio listeners, when he intercepted one of Cagle's passes and ran 98 yards for a touchdown. For this game, many folk arrived half an hour before the kick-off and people were still leaving the stadium more than an hour after the final whistle, which blew 1 hour and 59 minutes after the kick-off. Hence some spectators spent about 3½ hours at the field to see the ball actually in motion less than 12 minutes (to be accurate, in this game it was 11 minutes and 43 seconds).

The time studies of the eight games proved that the period the ball is in motion during each play averages only 4½ seconds. This is based on a total of 1328 plays, all of which were carefully timed with a stop-watch reading to tenths of a second. As might be anticipated, some of the plays lasted four times as long as the average. And it was indeed apparent that the amount of spectator excitement was in proportion to the time the ball was actually in motion. The spontaneous cheers and yells were all concentrated in these very short intervals and all eyes were figuratively glued on the field.

On November 30, 1929, at the Yankee Stadium, in the second quarter, the Army had blocked one of Notre Dame's punts but Notre Dame recovered the ball. Since the play was on the fourth down, the ball went to the Army on Notre Dame's 13-yard line. Things looked fine for the Army. Two plunges by Cagle and Murrell netted a few yards, and then Cagle whisked a delayed pass over the left side of his line. Elder of Notre Dame rushed in boldly and, instead of playing orthodox football for a goal line defense and knocking the ball to the ground while covering receivers of the pass, he snatched



the ball from the air on his two-yard line, lost a precious split-second in regaining his balance, and then tore madly up the side line. Two Army men dove for him but missed—by a few inches. He ran unmolested until he reached the Army's eight-yard line when another West Pointer failed—by inches—to catch his elusive prey.

The fleet Elder raced over the goal line for a touchdown. But no one knew then that he carried the game with him. Carideo booted over a placement for the extra point, ending the scoring for the day. The crowd had been held spellbound. For 18½ seconds—the time of that play—they forgot the bitter cold. It was the longest play recorded in the eight games analyzed.

In the Army-Stanford game at the Yankee Stadium on December 1, 1928, there was another long play. Here also Cagle had a hand in it, but this time he did the carrying. The Army had the ball on their own 34-yard line. It was snapped back several yards to Cagle, who made a dazzling zig-zag run through the entire Stanford team, dodging tackler after tackler, to Stanford's 44-yard line for a net gain of 22 yards. It was a thriller. The play lasted 15½ seconds, the longest play of the game, and second longest in the eight games

at which the time studies were made.

In the play which ranks third in point of time out of 1328, the performance of Christian Cagle of the Army is again encountered. This time it is in the Yale Bowl on October 22, 1927. With the ball on Yale's 48-yard line, Cagle received it about 12 yards back of the scrimmage line, and, by avoiding and throwing off Yale tacklers, down on his knees and back up again but never completely stopping, he carried the ball on another brilliant run of over 32 yards to Yale's 28-yard mark for a net gain of 20 yards. The total time of this play was 14½ seconds—14½ seconds bristling with thrills and gasps.

The average play in football—about 4½ seconds—hardly gives the spectators time enough to work up to a state of excitement. It remains for the long plays, such as the kind just described, to give the greatest thrills. It is these long plays that we like to see and read about. During each second of actual play the suspense is tremendous, and this is what really makes football the game it is for the spectators.

WITH the exception of the unusual plays such as those described, the punts consumed the greatest amount of time. They averaged about nine seconds, and the straight line plays three seconds. The average forward pass, counting those completed and also the incomplete, averaged about six seconds. The adoption of the pass has helped to spread the players more, and has served to increase the average time per play, thereby increasing the period of suspense and true excitement. Hence this change was a most important one from the spectator's standpoint—the standpoint that made half-million dollar gate receipts per game possible. Years ago the spectator saw little more than two struggling groups of 11 men each, pushing up and down the gridiron. The object was sufficiently apparent, but not the method of attainment. Consequently the game's power to draw paying spectators was not at its present height.

But what of the fact that the total time the ball is in motion during an entire game is only about 12 minutes? Shall we establish rules which will double or triple this period—the time during which the players are giving their every ounce of energy and the spectators are really getting the excitement they crave? No, it would not be wise to do so from either the spectators' or players' standpoint. Have you ever noticed that you are quite tired at the end of a football game, and particularly so if you are keenly interested in the outcome? As the ball moves back and forth on the field, you unconsciously push in the direction you would like to see the ball move. When the losing side cuts the air with "Hold 'em" they are unconsciously pressing their shoulders against an imaginary wall.

Students of public speaking and oratory tell us that a speaker who gets his audience extremely interested not only sways them mentally but also physically. It is said that the entire group of spectators at a football game actually moves with or against the ball, and by careful observation these waves of motion can be detected. Therefore, even though you may be paying at the rate of $24.25 per hour to see actual football, perhaps it is best for you that there is only 12 minutes of it. If you kept this tension steadily for an hour,

Cagle takes the ball

you might have to be carried out of the stadium.

And now from the player's standpoint. A man running the 100-yard dash in 9·3/5 seconds is expending energy and moving at a rate which he could not maintain for 30 seconds. He would become so fatigued, if he tried it, that his pace would slacken before he traveled 300 yards. So it is on the gridiron. The men are giving every ounce they have, while a play is being executed, and it is undoubtedly good that the time per play *is* only a few seconds. Under the present rules, the players—all of them who have played hard—are usually nearly exhausted when the final whistle blows. The law of fatigue holds for everyone, regardless of his physique; the time for fatigue to take effect varies, of course, in the individual.

Consider the wear and tear upon human endurance during the game, when men line up for action 140 to 180 times. Little wonder that a rugged physique and heroic courage are required of the players. Hence it now can perhaps be better understood why, toward the end of a game, some of their performances are not quite up to standard.

Scientists tell us that when a muscle is stimulated, lactic acid is liberated in certain parts of the muscle. As this stimulation continues, an alkaline solution neutralizes the acid, which tends to relax the muscle. The process can continue until the available supply of alkali for neutralizing the acid is depleted. Then the excess acidity of the muscle stops its further activity and a state of complete exhaustion has been reached. Our whole voluntary muscular movement depends on this chemical reaction with lactic acid. There is a very definite limit to the extent any individual can use his muscles before complete exhaustion sets in.

The best way to win a mile run is to continue at a pace which will just produce exhaustion at the tape. If the pace is raised beyond this point, untimely exhaustion is certain to take place and the race is lost. Naturally, the longer the race the slower will be the average speed for each individual. Consequently, if the present rules and method of playing football results in near-exhaustion of the players at the end of the game, a change in the rules so there will be more actual playing time, without increasing the total time between the initial and final whistles, would mean a slackening of the speed and deftness with which each play is executed. Such a change would certainly not improve the game for the spectators.

A STUDY of the tabulated results of the eight games, with the number of plays and the time elapsed, provides some very interesting and instructive data. The number of plays per game averaged 166. The average number of plays per quarter varied between 40 and 43. This indicates that the proposed plan to play the game on the basis of 40 plays per quarter, in place of a definite time interval, will give us just as much football per game as at present. And, according to Mr. Harry R. Coffin of Harvard and other advocates of the new system, there are some very definite advantages. They claim the suggested period-by-play method has the following merits:

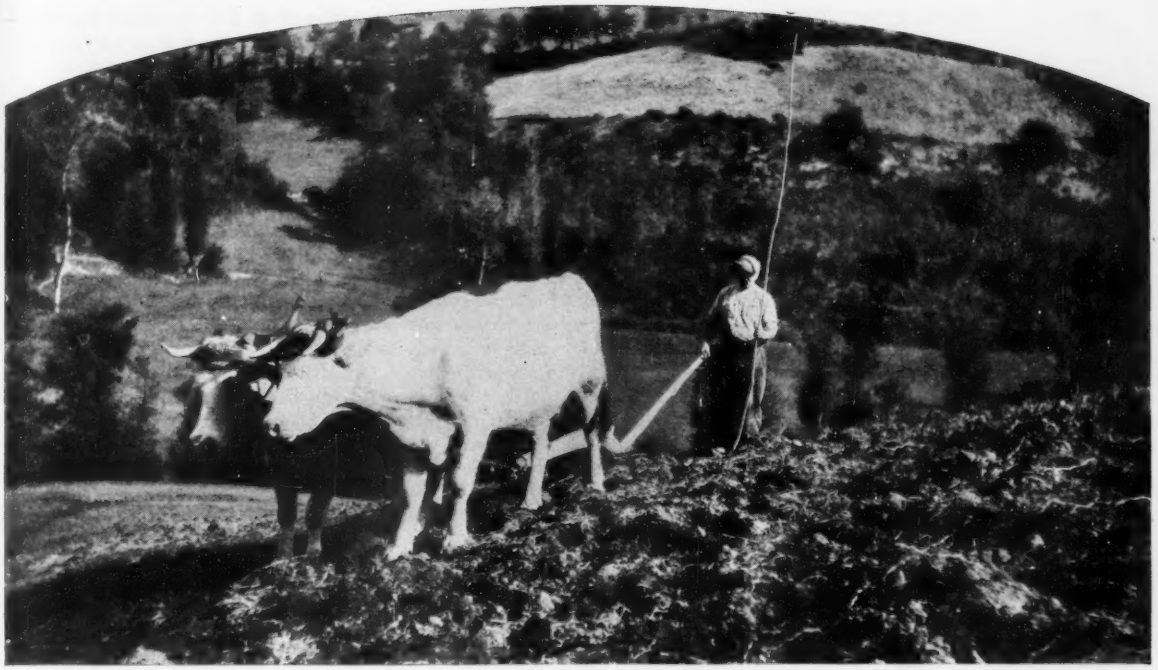
(1). It will eliminate the frantic use of the forward pass by the losing team during the final minutes of play.

(2). It will do away with any possibility of suspicious timing by officials.

(3). It will increase the interest of the spectators.

This system of playing was employed in the game between Brown University and Boston University in Providence on November 7, 1925, in which Brown won easily, 42 to 6. The consensus seemed to be that the score was too

(*Please turn to page* 411)



A member of the *Scientific American* staff also visited Glozel, as did the author of the accompanying article, and made this and other photographs. According to one account the original "discovery" at Glozel was made while the young farmer, Emile Fradin, was plowing with cows. By chance, on the day of the visit, one of the Glozelians likewise was plowing with cows and within a few feet of the famous discovery site, which was at left just out of the picture

THE STORY OF GLOZEL— A CHAPTER IN CREDULITY[1]

By DAVID RIESMAN

Professor of Clinical Medicine, University of Pennsylvania

THOSE who have read something about Glozel may wonder why I speak of it here. Is it not a dead issue? No, for as a study of human credulity and as a commentary on the hot-headedness (or should I say pig-headedness?) of many men of science it will always occupy a prominent place in the history of civilization.

Although many are probably familiar with the main facts, I want to give a brief synopsis of the involved story. I say "story" advisedly for from the very outset the mystery of Glozel has formed a fascinating tale; very much in the genre of our best thrillers, with plot and counter-plot, gum-shoe detectives, and all the pertinent paraphernalia.

Glozel is a small hamlet of four farmhouses, about 15 miles from the famous French spa of Vichy. Emile Fradin, then a youth of 18 and belonging to an old local family, was one day working in his grandfather's field when a cow suddenly slipped into an unsuspected hole. Fradin went to investigate and found that the hole led into an oval pit containing a variety of remarkable objects—bricks, tablets, vases—which he gathered and as soon as possible showed to the village school mistress, Mlle. Picandet. The latter in turn showed some of the tablets to M. Clément, a school teacher in la Guillermie.

EVENTUALLY the news of the discoveries came to the ears of Dr. Albert Morlet, a surgeon of Vichy and an amateur archeologist. Thereafter Dr. Morlet and Emile Fradin together began to excavate at Glozel and brought to light more and more buried objects which they collected in grandfather Fradin's house and which Dr. Morlet described in detail in an endless series of articles in a literary journal, the *Mercure de France*. It was through this magazine—the *Atlantic Monthly* of France in more senses than one—that I became interested in the Glozelian discoveries. My interest was especially aroused by the claim of Morlet and others that an alphabet had been discovered at Glozel which antedated every other alphabet then known. I therefore decided while spending a vacation in the Auvergne to see Glozel for myself, but before doing so I determined to interview Dr. Morlet in Vichy.

At first he suspected me of being an archeologist but when in answer to a direct question, I denied the soft impeachment and proclaimed myself merely a doctor, he became cordiality itself and showed me his collection of Gallo-Roman and Glozel antiquities. He told me that he as well as others had been inclined to consider Glozel as belonging to the Magdalenian age because of the presence of harpoons and of stones engraved with reindeer and other animals long extinct in France, but further studies had led to the conclusion that Glozel was Neolithic. Dr. Morlet kindly asked me to

[1]Presented before the American Philosophical Society.

The little museum in the Fradin farmhouse. The crude sign mentioned by the author shows over the doorway. The picture was taken by a *Scientific American* staff member while perched on an "island" in the nearby manure-pile-quagmire, an entity which provides the cheery aspect from the typical French farmhouse. To see the exhibits he paid a few francs, as did the author of the accompanying article and, like him, was watched every instant by one of the Fradins; like a cat watching at a mouse-hole

stay over until the following day and dig with him and Professor Björn of Sweden, but I was unable to do so.

After leaving Morlet I motored, together with two American friends, to Glozel. Emile Fradin received us and at once offered to take us to the field of excavation. It was at the bottom of a deep ravine and was surrounded by a barbed wire fence. He showed us the original oval pit and the two tombs subsequently discovered. As it was raining hard and as the clayey ground was slippery, I declined his invitation to crawl into one of the tombs but asked instead to see the Museum. After paying two francs each we entered through a low door above which was a crude sign with the pretentious words, "Musée de Glozel," and found ourselves in a square low-ceilinged room with shelves on the walls and very primitive glass cases standing on the floor. The objects exhibited on shelves and in cases were astounding in number and variety—vases, tablets, engraved stones, ornaments (especially pendants), some pieces of glass, and harpoons, the last not nearly as artistic as those of Magdalenian age I had seen in Les Eyzies and at Laugerie-Basse.

Three articles attracted my special attention—vases or vase-like pottery ware having eyes, nose, and ears but no mouth, which Morlet has called death masks, explaining the absence of the mouth by assuming that the primitive makers wanted to express the silence of the grave. Secondly, a squarish object suggesting the female figure with a cylindrical projection from the forehead interpreted as the phallus—this Fradin told me was a bisexual idol; and most striking of all, clay tablets with graven signs looking in every way like alphabetical characters. I was struck by the clean red color of these tablets. When I spoke of this to Fradin, he explained it by saying that the soil in which the tablets had been found was such that it did not readily fuse with the clay and hence was easily brushed off. There were also some large casts of the human hand which differed from the imprints of the hands in the Spanish and French caves in having all the fingers present.

I offered to buy some of the articles, especially a tablet, but Fradin resolutely refused to sell. During the whole of our stay in the Museum, the grandfather stood silent and motionless in a doorway leading to an inner room.

The reputed discoveries of an alphabet dating back to Neolithic times, of which I had now seen the alleged evidence in abundance, created a tremendous sensation in informed circles. Altogether about 136 characters had been distinguished, representing every letter of the alphabet except the letter B.

Hitherto the credit for creating an alphabet had been given to the Phoenicians but the oldest known Phoenician record, found at Byblos a few years previous, dated back only to about 1300 B.C.; Sir Arthur Evens' baffling Cretan inscriptions to about 3000 B.C. If Morlet and those who agreed with him were right, then Glozel was truly what M. Reinach called it—one of the greatest archeological discoveries of all time.

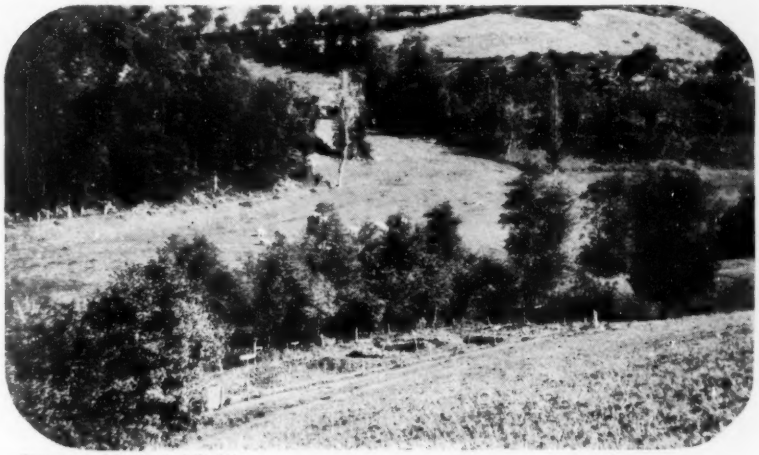
ALMOST immediately after the first appearance of Morlet's reports, doubts began to be voiced about the authenticity of Glozel, though in the early period of the controversy there were perhaps as many scientists who accepted the discoveries in good faith as there were doubters. Soon the pro- and anti-Glozelians became personal and attacked each other with a vituperative vehemence and a destructive sarcasm for which the French language appears to be the ideal medium. Reputations were shattered, old friendships broken, and as one of the French dailies remarked—even butcher boys came to blows on the streets of Paris. In fact Mrs. O'Leary's cow did no greater damage to Chicago than Fradin's to the reputation of some French savants.

Before long the leading French pre-

Herbert photo

The principal, Emile Fradin, about 21 years of age at the time the site was investigated by the Committee. Although a humble peasant he had done better than average in school; he also was artistic and had done water color paintings. Perhaps it was a coincidence that the Glozel forgeries improved in technique from time to time as the schoolmaster Clément loaned Emile different pieces of literature on prehistory. The output of discoveries also corresponded with books given him by other interested dupes; it even accommodated itself in nature to the hopes and objections they expressed. Oddly, all periods of prehistory were represented by the objects discovered, from the Old Stone Age to historic times, and it is another coincidence that the illustrated textbook of prehistory in Fradin's possession covered the same scope. Picture taken in the museum

historians with only an occasional exception began to deny the authenticity of Glozel and to declare the excavated articles to be forgeries. A number of Englishmen were likewise unconvinced. However, Dr. Foat, a London scientist, makes the categorical statement that "if the finds of Glozel are not authentic, it is equally necessary to consider as false all that I have seen in museums between London and Constantinople." Several Scandinavian, Belgian, and Portuguese scientists also supported Dr. Morlet, and a German, Dr. Wilke, in a recent article enthusiastically upholds the standard of Glozel.



SCIENTIFIC AMERICAN staff photo

The actual site of the famous finds, at the lower end of a steep field above the valley of the Vareille stream. An attractive setting. The barbed wire fence around the site shows in the picture. It is easy for the tourist to reach Glozel; one goes to Vichy, where there are fine hotels, and hires a car to nearby Glozel

ARE Dr. Morlet's supporters right or is Glozel but one more of the long series of frauds that history recounts since Jacob imposed upon his father Isaac? Many will come to your minds—Thomas Chatterton, our own Dr. Cook, Constantine Simonides, the pretended author of the *Codex Sinaiticus*, the forger of the Mecklenburg Declaration, the Lincoln love letters in the *Atlantic Monthly*, the Tiara of Saitapharnes, and countless others.

One of the most interesting cases and the one having the greatest analogy to Glozel, if Glozel be a fake, is that of the so-called "Figured Stones of Würzburg." In the first half of the 18th Century there lived in Würzburg, in Bavaria, an ultra-pious physician named Johann Bartholomaeus Adam Beringer. He is not remembered for any great discovery or contribution to science, but for his share in a remarkable scientific hoax. At the time in which Beringer flourished an active discussion was going on as to the source and meaning of fossils. Although Leonardo da Vinci had understood their true nature—even Herodotus, 400 B.C. had a correct idea—the scientists of 200 years ago accounted for them as the result of "stone-making forces" of "formative qualities" or as growths from seeds. We may be inclined to smile, but with Dayton in Tennessee to chasten us, we can not throw stones at the Würzburg of two centuries ago nor at the Sorbonne which a hundred years later deprived the great Buffon of his chair because of his heterodox theories.

Beringer had committed himself publicly to the belief that fossils were the capricious fabrication of God, hidden by Him in the earth for some inscrutable purpose. His zealous maintenance of this fundamentalist position led some of the students, together with members of the faculty and wags of the town, to make numerous "fossils" of clay which they buried in the side of a hill where they knew the Professor was wont to search for specimens. Beringer, chancing upon these objects, was completely deceived. The jokers became bolder and buried the most extraordinary and extravagant figures their whimsical imagination could suggest. They fashioned tablets bearing inscriptions in Hebrew, Babylonian, Syriac, and Arabic, and buried them not far from the original spot. Beringer was overjoyed to find such abundant confirmation of his doctrines and forthwith in true German fashion proceeded to write an exhaustive treatise.

From the SCIENTIFIC AMERICAN MONTHLY, November, 1920. L. A. Hausman

Some of the famous Beringer fakes

THE wags now began to realize that they had gone too far. They expostulated with him and even told him the whole truth. Instead of believing them Beringer became more than ever convinced that the story his frightened colleagues told him was a ruse to rob him of the honor of his discoveries. No one could stop him. At great expense he published in 1728 the "Lithographiae Wirceburgenses."

Only too soon the shout of laughter with which the book was greeted brought the truth home to him. In chagrin and despair he exhausted nearly his entire fortune in a fruitless endeavor to suppress the edition and to buy up the copies already issued. He died soon afterwards, it is said, of a broken heart.

Is Dr. Morlet, like Johann Beringer, the victim of deception? Upon me personally he made the impression of an honest man. In certain quarters he was accused of fraud, for example, by the "Journal des Debats" and by the French Society of Prehistory. He promptly brought suit against them and won a

Herbert photo

Exhibits in the museum of Glozel. Some are pots having eyes, nose, and ears but no mouth, as Dr. Riesman relates in his article. The "idol" to which he refers may be seen. Most of the objects in this picture are of pottery but the other finds have a wide variety— engravings on bone and stone, chipped flint and bone artifacts, and so on, representing a prodigious amount of industry on the part of (?)

verdict of 1000 francs damages. The defendants carried the case to the Court of Appeals at Riom, the native town of Willa Cather's lovable archbishop. In confirming the verdict, the Court gave expression to an amusing quibble. It held that Morlet, being a surgeon by profession and only by avocation a prehistorian, was not injured in the eyes of his real colleagues but only as an amateur archeologist. But as the defendants had not actually proved fraud, they were declared guilty though the fine was reduced to one franc and costs.

ANOTHER humorous episode might be mentioned. Regnault, President of the French Society of Prehistory, sued a Monsieur X because he, Regnault, had been compelled to pay the sum of four francs to see a collection of fake objects. As part of this legal action, the police of Moulins broke into Fradin's premises and took away a number of objects which were afterwards submitted to the public expert, M. Bayle. The latter reported that the tablets were of recent manufacture. Pieces of clay from a tablet crumbled readily in water; hence it was not conceivable that the tablets could have resisted the moisture in the ground had they been there for many years. Furthermore, a bit of grass picked out of a piece of earthenware showed under the microscope the vegetable cells, and some of the bone instruments still contained marrow. Bayle was soon afterward shot to death by one Philopponet against whom he had testified in court.

The Fradins themselves brought suit against M. Dussaud, member of the Institute, who in a trenchant brochure had called them fakers.

Let us now delve a little more deeply into this mystery so that we may understand better the basis of the controversy. The first serious doubt as to the authenticity of Glozel was based on the heterogeneity of the articles in Fradin's museum. How could one explain the presence of so many disimilar and unrelated objects—the 2000 or 3000 at the time of my visit have now grown into 5000 in one small field of excavation. No other archeologic site offers a parallel.

From "Glozel" by Dr. A. Morlet

One of the many inscribed tablets. After a fancied resemblance to the old Phoenician alphabet was mentioned the subsequent "discoveries" oddly came more and more to resemble Phoenician. Later, M. Bayle, the "Sherlock Holmes" of France, found minute strands of cotton colored by aniline dye in one of the clay objects. Perhaps, however, the apologists for the Glozel incident would say this proved that Neolithic man of Europe (5000 to 11,000 years ago) understood the synthetic chemistry of dyes

Morlet answered this by saying that Glozel was a *Champ des Morts*, a cemetery; and that, as among many primitive peoples of later times, everything belonging to the dead had been buried with him. C. Jullian, who considers Glozel a Gallo-Roman station, accounts for the multiplicity of objects by the assumption that Glozel was a sorcerer's sanctuary. He has added greatly to the gaiety of nations by attempting a full translation of the inscribed tablets from the published illustrations. Dr. Morlet showed me with much amusement a crack in one of the tablets which Jullian had translated as a character.

Aside from the puzzling complexity of the collection, it has been pointed out that the tablets first exhumed bore fewer and less perfect characters than the later ones. Further, as soon as some one had made a criticism, the objects next exhumed were free from the criticized defect. Quite often certain features appeared that could be traced directly to scientific articles published shortly before. These facts seem, of course, very significant. Moreover, the scratches on stones, whether representing animal figures or alphabetic characters, were without the patina covering other parts of the stones, suggesting a recent production. Much was made of the penetration of roots into vases or tablets; but upon examination these roots were not found to be properly fossilized, which would have to be the case had the objects been in the ground for long ages. The utensils—harpoons, hand axes, scrapers—are far less artistic than those in other Neolithic stations. Vayson de Pradenne and Abbé Breuil indeed contend that none of them could ever have been used.

DR. MORLET and his chief supporter Van Gennep did their best to answer all these objections. The former at the height of the verbal battle-royal made a request for a governmental commission which was speedily granted, but when he found that a bitter anti-Glozelian, the well-known archeologist Capitan was a member, he objected and the Commission was never sent. Eventually, at the International Anthropological Congress at Amsterdam an International Commission was formally appointed to investigate Glozel. The Commission consisted of Absolon, Director of the Archeological Museum of the State of Moravia; Bosch Gimpera, Professor in the University and Director of the archeological work of Barcelona; the Abbé Favret; Forrer, Director of the Prehistoric and of the Gallo-Roman Museum at Strassburg, Miss Dorothy Garrod, Member of the Royal Anthropological Institute and of the French Prehistoric Society; Hamal-Nandrin, Lecturer on Prehistory in the Museum of Liège; Peyrony, Director of the Museum of Les Eyzies; and Pittard, Professor of Anthropology in the University of Geneva. Absolon was prevented from taking part in the work of the Commission.

After spending three days at the site the Commission issued a unanimous report which was kindly sent to me by Miss Dorothy Garrod. This report

states unequivocally that the articles are for the most part of recent manufacture and have undoubtedly been planted in the ground by some one whom the Commission does not name; and that Glozel is neither prehistoric nor authentic. Vayson de Pradenne in a devastating brochure in which he declared the Glozel finds fakes, also accused no one by name but put the blame upon the "Esprit de Glozel;" in other words upon a fairy.

ONE might think that with the leading French, English, and American scientists—Peyrony, Pradenne, Abbé Breuil, Sir Arthur Evans, Dussaud, and, I believe, Professor MacCurdy—arrayed against Glozel, and with the destructive judgment of the International Commission, Glozel would cease from troubling the scientific and the lay mind. Though all due obsequies have been performed, Glozel refuses to remain in its sepulchre, and the literary battle continues. Dr. Morlet constantly sends me newspapers and pamphlets[2] and a distinguished pro-Glozelian of Belgium, Professor Tricot-Royer, has just supplied me with his defense of Glozel which is particularly interesting because Professor Tricot-Royer was present during the visit of the International Commission.

What keeps Glozel alive? First we have the fact that when men take sides in print they are loathe to recant, fearing ridicule—the more untenable their position, the more stubborn their resistance.

Secondly, six months after the International Commission's visit Dr. Morlet called together a Comite d'Etudes consisting of Dr. Foat, Bayet, and Tricot-Royer of Belgium, Reinach, J. Loth, W. Loth, Van Gennep, Deperet, Ajcelin, Roman, Audollent of France, and Soderman of Sweden; all sympathetic to Glozel. At their meeting they pronounced unanimously in favor of its genuineness.

Another reason is found in the attitude of a group of French and German scientists who are opposed to the traditional belief that *ex oriente lux*—that civilization is of oriental origin. The alleged Neolithic alphabet of Glozel and similar finds at Alvao in Portugal are grist to their mill.

In addition quasi-political factors have entered into the controversy—Fradin an obscure peasant, Morlet a provincial doctor without much influence, have a definite appeal for the proletariat and for a large section of the press.

And finally, it must be remembered that the Academicians are not always right—that they ridiculed Pasteur and Boucher des Perthes; and even Koch and Lister met a similar fate in the beginning.

All these elements co-operate to keep the spark of life in Glozel. Within the past few weeks the publication of an exhaustive treatise by Dr. Morlet has been announced.[3] This, however, I fear, can throw no new light upon the subject.

As a detective tale the story of Glozel remains unfinished and will remain so until a Sherlock Holmes discovers the person or persons who manufactured the articles and put them in the ground. What was his motive? How are we to explain the extraordinary industry that has fashioned 5000 or more articles, and how is it that he, the "Esprit de Glozel," escaped detection in a community of 29 souls where everyone knows everyone else's business. Or how, if there are witnesses to the dark deed, can we explain an unbroken neighborly silence extending over a period of six exciting years?

[2]Similarly, the enthusiastic Dr. Morlet has sent clippings, newspapers, and pamphlets, and his publisher a book by the doctor, to a member of the *Scientific American* staff who, when passing through Vichy, attempted to see him, but who was given to understand by some one within the Morlet household that the doctor was seeing no one, and who left his card. Residents of Vichy suggested that the doctor was finding it expedient to "hide out" at the time, until the legal storm might blow over. —*The Editor*

Herbert photo

"The International Commission" of scientists making an official investigation

Herbert photo

Dr. Morlet demonstrating his claims at the site, before the members of the "International Commission" of investigation. Vayson de Pradenne, president of the Prehistoric Society of France, in *Antiquity*, characterises him thus: "Still young and endowed with wild energy, with an inflexible resolution and a naïve and immoderate self-esteem; devoid on the other hand of competence and of the critical faculty, he threw himself whole heartedly into the fray"

[3]"Glozel," by Dr. A. Morlet, a copiously illustrated work published by Georges Desgrandchamps, 23 rue Boissonade, Paris (XIV[e]). The especially interested reader will find a 20-page article entitled "The Glozel Forgeries," by A. Vayson de Pradenne, President of the Prehistoric Society of France, in the journal *Antiquity* (Gloucester, England), Volume 4, No. 14. Several *Cahiers de Glozel*, some by Dr. Morlet in his own defense, have been published by Paul Catin, 3 rue Sabot, Paris (VI[e]); other matter, by Octave Belin, 26 rue Pasteur. —*The Editor*

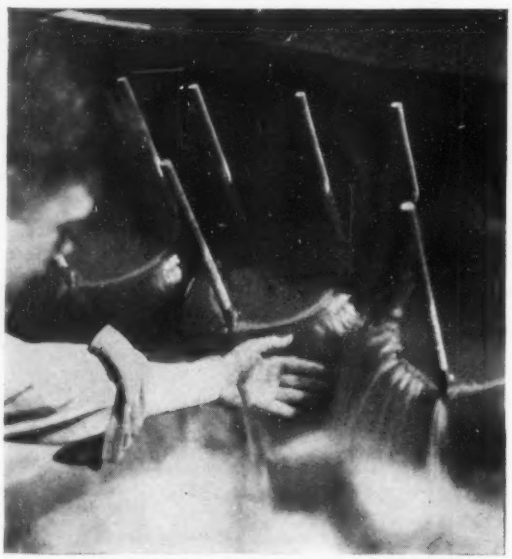
BY-PRODUCTS FROM INDUSTRIAL WASTES

By ERNEST W. STEEL

Professor, Municipal and Sanitary Engineering, Agricultural and Mechanical College of Texas

A STATE legislator not long ago seriously advocated the abolition of the state health department, and by inference all health departments, on the ground that at best they were wasters of public funds and nuisances. Persons of the same opinion may be surprised to learn that the complaints of health officials have stimulated industries to reclaiming large amounts of valuable materials which were wasting unheeded into streams and municipal sewage.

The liquid wastes of many industries are of such a nature that they cause serious troubles in streams and at municipal sewage treatment plants. In the streams, fish are killed and the water is made unsuitable for water supplies and recreational uses. At the sewage treatment plants, the biological action may be upset by antiseptic substances, or the enormous volumes of organic matter from the industry may overload the plant to such an extent that it must be increased in capacity or must bypass untreated liquid into streams. Accordingly, many industries have in the past few years been notified by cities and state health departments that the burden of waste treatment must be assumed by the industry, either completely or in large part, before final discharge into sewers or streams is permitted.



Clear overflow from equipment that reclaims an appreciable amount of wood fiber from the discharge water in a paper plant. Where this is not in use, the discharged water pollutes streams and kills fish

SUCH notices have been received with apprehension by the industries concerned until study of the problem showed that what appeared to be a liability was capable of returning profits. An example of this is the Corn Products Refining Company of Argo, Illinois, which manufactures starch and other corn products. Final disposal of its liquid wastes is a matter of much concern to the Chicago Sanitary District. The chemists of the District found that the wastes of this plant were so large in volume and contained so much organic matter that they were equivalent to the sewage of a population of 800,000. The treatment of this waste was, of course, too great a burden to place upon the taxpayers. The alternative appeared to be the construction by the company of a special treatment plant, estimated to cost 2,900,000 dollars.

Investigation of the plant with respect to sources of the waste indicated that a considerable portion of valuable product was escaping into the waste pipes through poor control of certain processes. Improved mechanical equipment and weeding out of heedless operators remedied this. Result: a 10 percent decrease of the waste, and an increased output.

The greater portion of the waste, however, was composed of the liquor in which the corn is first steeped and softened. By installing comparatively inexpensive equipment the steep-water can now be evaporated to such a consistency that it can be used for making a stock feed. Result: an annual return of 500,000 dollars which was formerly lost through waste, and a reduction of volume and concentration of the plant waste from a population equivalent of 800,000 to about 50,000. The present wastes owe their strength to the organic matters distilled over in the vapors of the steep-water during the concentration process. It is possible that some valuable constituents can still be extracted, and further experimental work is being carried on.

Another industry which has frequently been embroiled with health departments is that of coke making. Coke is made by distilling coal, and many valuable products are in the distillate. After these are removed, there remains a liquid containing tar acids and phenol, or carbolic acid. The latter is especially troublesome, particularly if the stream or lake which receives the wastes is a source of municipal water supply within many miles of the point where the waste enters. If the water supply is chlorinated, the phenol taste is particularly bad. The disagreeable medicinal taste of the combined phenol and chlorine has been noticed when the water contained only 1/25 of an ounce of phenol to a million gallons of water. Methods of recovering phenol from the still-waters have been developed and now it is possible to extract it and obtain salable phenol in amounts sufficient to pay the cost of extraction.

THE phenol problem has also received much attention on the part of scientists of France, Denmark, and Germany to prevent pollution of the relatively small rivers of those countries. From their studies comes a new and startling solution. It has been found experimentally that if the phenol-containing liquid is applied to the soil, the injurious constituents are converted into ammoniacal compounds which can be utilized by soil bacteria and act as crop fertilizers. The conversion process takes about two weeks. Previous to the change, of course, the phenol is injurious to plant growth and accordingly the liquid must be applied a proper length of time before sowing. A very important advantage claimed is that, while the phenol is still active, it will destroy weeds and injurious insect larvae present in the soil. The combination of fertilization and weed and insect killing properties may change entirely our methods of disposing of this troublesome waste.

In the bituminous coal mining regions of the eastern states there have

been many disputes between mine operators, cities, state health departments, and fish conservation commissions. The drainage water of coal mines contains little or no dissolved oxygen and hence will not support fish life. It will so lower the oxygen content of streams into which it discharges that fish cannot live in them. Mine wastes are even more troublesome because of the acid and other chemicals which they have dissolved out of the coal beds. Acid is a killer of fish and in addition makes the polluted streams black and evil smelling and unsuitable for municipal water supplies. The only remedy found so far has been to require owners of mines to seal up those abandoned workings from which drain water trickles down the hillsides. Lately, however, the Kaplan process is reported from West Virginia. It consists of adding to the mine waste a complex chemical which combines with the undesirable chemicals to form a useful blue pigment, which has a far greater value than has the chemical reagent added. Appropriately enough, the new pigment has been called Monongahela blue.

IN all of the forested states are mills engaged in turning wood into various grades of paper. The process requires much water—to break down or digest the wood into fiber, to wash it after digestion, and to convey the fiber around the plant through pipes and channels. Indiscriminate discharge of the wastes has changed streams which traverse regions of great scenic beauty into black and evil-smelling open sewers. Fish are destroyed. Regions which are ideal for camping, fishing, and vacationing are spoiled.

The paper industry, however, after exertion of much pressure by state health and game officials, is doing much to remedy the situation. Study of plants indicated that much of the conveyor water with its valuable fiber was escaping accidentally or through remediable carelessness. Some fiber unavoidably escapes from the paper machines. This waste is being reclaimed by special patented sedimentation processes which allow return to the plant of the rescued stock. At some plants the water, after removal of fiber, can be returned for further use. This is especially profitable where the water must be pumped long distances from the original supply or must be filtered or otherwise treated before it can be used.

The wastes from the digesters and washers contain much chemical matter that is especially undesirable in streams. The chemicals need not be lost, however, and most paper plants are now installing systems for evaporating this waste. After evaporation, the residue is burned and the chemical is regained in a modified form. The magnitude of this procedure is indicated by the fact that 7000 gallons of water must be evaporated for each ton of pulp manufactured.

Most troublesome of all problems to the paper industry is the disposal of the highly corrosive liquid wastes from the sulfite pulping process. Some progress has been made by some plants which are converting the waste into adhesive and other by-products having commercial value. Experimentally, investigators have found that alcohol, road binders, linoleum cements, dyes, fertilizers, and many other products can be made. The difficulty is that sulfite waste is produced in such enormous quantities that if all of it were converted into by-products, the market probably could not absorb them all, although alcohol manufacturing may possibly be the final solution.

THE textile industries also produce troublesome liquid wastes. Foremost among these in difficulty of treatment is wool-scouring waste. It contains much dirt, wool fiber, and grease. Wool fibers can be caught on fine screens and returned to the plant. Grease is highly undesirable at sewage treatment plants, and wool-scouring establishments are required, or at least encouraged, to remove all grease before discharging wastes into sewers. After removing grit and heavy dirt, the waste is treated with sulfuric acid which changes the grease into a thick scum and sludge easily removable from the liquid. The scum and sludge are then pressed and the grease is squeezed out. The grease so obtained is very largely lanolin, which is much used as a base for medicinal ointments. The cake that is left behind after grease extraction has some value as a fertilizer.

The most frequently encountered waste is that from plants which handle milk or manufacture milk products. At sewage disposal plants, milk waste sours and upsets the normal bacterial action. Discharged directly into streams, the usual results of stream pollution, nauseous odors, and killing of fish follow. The whey from cheese-making plants is especially troublesome in this respect. Whey has been found to be a valuable hog food and is returned to farms for that purpose. The ordinary milk wastes contain much casein. It can be precipitated by small amounts of sulfuric acid and the resulting thick sludge fed to chickens or hogs. Since casein has many uses in the industries and can be converted into glue, or into poker chips and other artificial ivory objects, it is highly probable that the large condensed milk and cheese factories will eventually salvage this material.

IN spite of the progress which has already been made, stream pollution by industries is a rapidly growing problem. This is due not only to the increasing industrialization of the country but also to the tendency of industry toward decentralization. Formerly industries grouped in certain regions or in the large cities. Their wastes, together with the domestic sewage of the large concentrated population, were discharged into the large rivers, lakes, or harbors where centers of population naturally developed. Comparatively few bodies of water, therefore, were grossly polluted. Now, however, factories of all kinds are scattered over the country. Advantageous as this may be to the industry and to its employees it has been harmful to many streams.

Possible damages to streams should be a matter of concern to all industries contemplating relocation. Town and city officials who are tempted to bid eagerly for a new industry would do well to inquire into the nature of the wastes which it may unloose upon the countryside. Should deleterious wastes be features of the particular manufacturing process, an agreement as to their disposal may prevent unpleasantness. Finally, where wastes are already causing trouble, scientific inquiry, carried on by the industry in co-operation with the proper governmental authorities will probably bring about a solution to this problem, the growth of which is measured by the growth of industry.

Milk wastes discharged into streams cause harmful pollution. This photograph shows creamery wastes being used to irrigate a farm

THE YOUNG GIANT: NATURAL GAS FUEL*

THERE was a slight trembling as, 480 feet below the surface, the crude string of tools dropped into a pocket. The trembling became a dull rumbling, like distant thunder, and the rumbling a rapidly swelling roar until there burst from the mouth of the rough casing a mighty column of mud, oil, and water, borne on the driving fist of a tremendous pressure that rocketed tools and equipment high into the air.

The drillers cheered. At last, after two years of slow, plodding effort, they had struck oil. They were rich.

But their cheering was short-lived. The dark stream soon thinned out and then disappeared altogether, leaving only a colorless substance escaping into the air and a roaring noise that seemed to mock them. The well was a failure, it seemed, for they had struck, not oil, but a gas pocket.

For days the terrific pressure blasted millions of cubic feet of natural gas into the atmosphere in an ignorant waste that would make the gas producer of today weep, while the owners of the well stood around disconsolately and wondered if any oil would follow. Finally, after weeks of waiting, they gave up hope. Some months afterward the roaring gas jet was ignited and the towering torch lighted the countryside for miles around, symbol of a later day when natural gas would be burned for heat and power in home and industry.

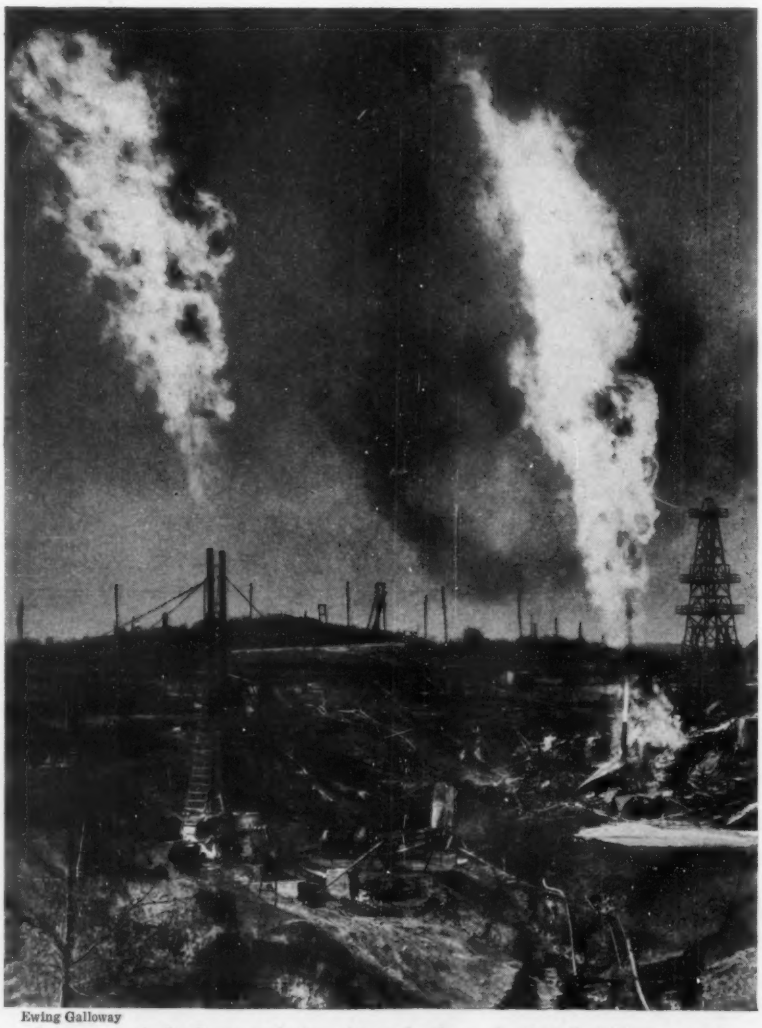
THE above incident, which is typical of hundreds, probably, in the early boom days of the petroleum industry when oil was the gold men sought, actually took place at West Bloomfield, New York, in 1865.

As a matter of fact, natural gas is as old as petroleum in the experience of men. But because it was often practically invisible, ignorance shrouded this masquerading giant of power in a veil of superstition for many centuries. The ancient oracle of Delphi is said to have been situated near natural gas fissures. According to the story, a shepherd noticed that some of his goats wandered about queerly in a certain spot. Going over to investigate, he felt a certain lightness coming over him. Villagers came at his call and immediately experienced the same dizziness, talking in disjointed sentences. So they concluded that a god must live there who had cast a supernatural spell on the place, and accordingly built a temple on the spot.

The Chinese and Japanese may have been superstitious too, but apparently they didn't let their fears blind them to the useful nature of the product. Plenty of evidence has been found to show that these people burned natural gas and even transported it in crude lines made of bamboo or animal intestines. History is full of similar instances. But it was not until 1821 that the first gas well was sunk near a spring at Fredonia, New York—a good 38 years before Colonel Drake's historical oil well at Titusville. Like petroleum, however, gas had been discovered before while boring for salt.

Between superstition, ignorance, and, later, mechanical difficulties of production and transportation, it has taken man many centuries to tame the "wild spirit" of prehistoric times and put it to work for him. A natural gas pipeline map of the United States would show a connecting maze of gas lines in many parts of the country, yet not so very many years ago natural gas was only a by-product, a waste that had to be blown off sometimes before the oil came; or, at best, something that held the pressure which carried petroleum to the surface and saved a certain amount of pumping.

Natural gas operations represent literally an "industry within an industry." Yet the business of producing, transporting, storing, and marketing this



Ewing Galloway

A scene typical of many during the early days of oil well drilling: a well comes in with a roar of gas which, accidentally becoming ignited, is wasted

*Reprinted through the courtesy of *The Lamp*.

product differs widely from that of petroleum in many respects.

Consider production. In appearance, a gas field looks very much like an oil field to the layman. There are much the same derricks, tools, toolsheds, and pipelines. But the problem of pressure is much more vital in gas operations. The producer cannot put his well on the pump, as the oil man can, when the pressure fails. And the first well down in a new field, naturally enough, gets the full pent-up pressure of the entire area, which may be considerably reduced by the time other bits reach the gas-bearing sand. On the other hand, pressure is not always an indication of how prolific a field is likely to prove. Many an apparently promising area has come suddenly into being, yielded abundant stores for a year or more and then just as suddenly gone dead.

Just as difficult is the problem of transportation. Where the oil man can ship his product by pipe-line, tanker, tank car, by barge, in barrels, or in any other way that emergency may suggest, the gas producer has only one channel of transportation—pipe-lines.

ONE of the most perplexing problems, however, which the industry has had to face—one which has largely been solved by developments entirely without its sphere—has been that of marketing. As might be expected, the first use of natural gas was in the home. In areas within reasonable distance of producing fields, natural gas could be supplied cheaper, very often, than the manufactured product. But here the industry was up against the problem of seasonal demand. Inevitably, extremely cold days multiplied the drain on his pipe-line system eight to ten times. Just as surely, morning and evening drew heavily on the lines, with consumption comparatively slack during the day. Natural gas can not be manufactured as needed. If the supply is too great, the product must be kept in the ground. If it runs short, the producer has to find new fields if he expects to stay in business.

Let's see what the industry has done to get around these obstacles.

First of all, there is far less waste than in the old days. Seldom does one see gas blown wantonly into the air from wells sunk into strata containing both gas and oil. The former is far too useful for re-pressuring oil sands—to say nothing of its commercial value—to throw away. Next is the matter of storage. The producer today has found that by far the most efficient and economical method of storing his product is right in the ground from which it came.

It has been the widespread growth of industry and manufacturing, however, which in the last analysis has changed the whole outlook of natural gas markets, given the producer an incentive for seeking new and richer fields, and economically justified the huge capital expenditures for lines from producing areas to industrial centers.

A rugged ten miles of scenery on the Denver gas line. In distributing gas from the fields, pipe-lines must be laid across mountains and through rivers

The United States is the greatest manufacturing nation in the world. Nor are the factories and industrial plants of the country now crowded into the northern states, as they were in former years. Today industry thrives in the south and west where formerly cotton pickers crooned in the sun and cattle roamed the plains. The natural gas business was quick to realize that here was a chance for mutual development. Its new customer would consume gas in large quantities, and at a comparatively uniform rate throughout the year. In return, the industry could offer him the cleanest fuel known to science with a high heating value of approximately 1000 B.t.u. per cubic foot, one that burns completely with no smoke or ash.

It has been estimated that there are over four billion dollars invested in the United States today, in the various producing and marketing areas scattered over the map, with thousands of miles of trunk and feeder lines, like spider webs in a garret. The output of energy from natural gas burned in the United States during 1929 was estimated to be equivalent to 527 billion kilowatt hours—nearly six times the total production of electricity for the same period. Known fields, with improved methods of computing reserves, give the industry almost unlimited supplies of raw material to work with. Texas Panhandle and the Monroe-Richland field alone can assure the industrial markets of the south and middle west of adequate resources for many years to come. Yet all these assets of supply, scientific methods, and expanding markets which Nature, their own inventiveness, and evolving conditions have given the men engaged in natural gas operations, might well prove to be so many stones, yielding no profit, were

it not for one thing. The industry has found to a remarkable extent the way to real practical co-operation.

The natural gas business is not a one-man job, so to speak. The product itself is easily susceptible of waste; and producing areas, unless scientifically drawn upon, may lose much gas that never reaches the market. The laying of lines from field to market involves the expenditure of millions of dollars. In distributing the product to numerous towns along the right of way, as well as at the destination of the main line, countless local interests have to be taken into consideration.

Here, then, is an invaluable natural resource. To bring it from its age-old prison, thousands of feet under the earth, to the burners of various industries in widely separated parts of the country, calls into play hundreds of varying interests. Producer, landowner, engineer, municipality, consumer, scores of others, all have their rights; all must be considered. The tiniest cog can wreck the whole machine.

SO the tremendous projects which have been successfully swung by the natural gas industry speak volumes for the fine degree of co-operation, orderly exploitation, and scientific development within its ranks.

The eastern section of the United States was the cradle of the natural gas industry in America. From the producing fields in West Virginia, Pennsylvania, and east Ohio has crept a maze of pipe-lines carrying fuel to the scores of industrial centers throughout that territory, until the map takes on the appearance of a jig-saw puzzle. Today those eastern subsidiaries of the Standard Oil Company (N. J.) operate something like 16,000 miles of main and feeder lines, with estimated distribution for 1930 of 104 billion cubic feet of gas.

Yet, even before eastern markets for natural gas had developed to their present proportions, the wildest gambler would never have undertaken to pipe the product to Baton Rouge, St. Louis, or any of the great centers of the south or middle west. The industry would have laughed at him. And—at that stage of development—it would have been right. Production methods were not as scientific as they are today. Nor were the compressors and lines of a quarter century and more ago as efficient as they are today. Men had no way of estimating with any degree of accuracy the potential output of a field, and the industry could hardly be expected to gamble an investment which it would have to carry 10 or 20 years on the chance that the elusive material in the sands under their wells would last that long. Finally, many of the markets in the south and middle west were not yet ready for natural gas.

So fate played a fortunate trick on the industry in hiding from geologists the prolific Monroe-Richland and Panhandle fields until a time when the engineer and consumer had prepared the scene for more extended use of their treasures.

Panhandle is undoubtedly the greatest natural gas producing field in the world today, with the Monroe-Richland area not far behind. It is almost impossible to estimate how much gas lies locked in the sands of these two fields, needing now only the turn of a valve to release it. But a fair idea may be gained from the fact that the combined capacity of lines already tapping them runs up to several hundred million cubic feet daily.

Amarillo field alone, in the Panhandle district, was thought two years ago to hold some 10¼ trillion cubic feet—enough to keep a line of 100,000,000 cubic feet per day capacity operating continuously at full force for nearly 300 years. That this great natural wealth may be expected to last many years is plainly testified by the investments of many millions which have gone into the construction of 300-, 400-, and 500-mile lines.

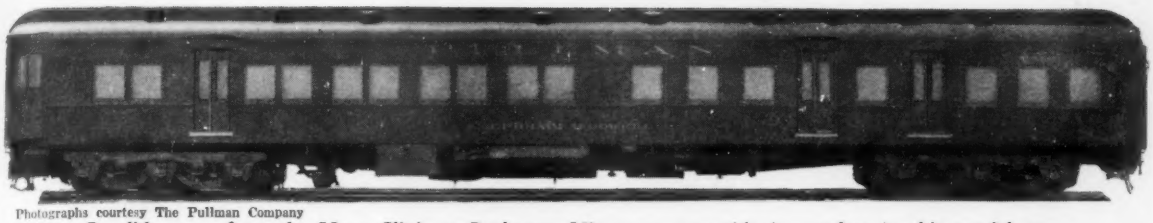
There are three main projects through the south and southwest in which Standard Oil Company (N. J.) subsidiaries have an interest, the most recent being the Mississippi River Fuel Corporation's 431-mile line from Monroe to St. Louis. In addition to the main line, branches will make the gas available to industrial plants in Crystal City, Missouri; and in East St. Louis, Granite City, and Alton, Illinois. Other industrial consumers within reach of the main line through Louisiana, Arkansas, and Missouri also will be served.

In 1927, the Interstate Natural Gas Company completed its line from Monroe to Baton Rouge. The Interstate also contracts to furnish gas from its Monroe reserves for the Southern Natural Gas Corporation's line to Birmingham, Alabama; Atlanta, Georgia; and various adjacent points, as well as to several other interests. Over in Texas the Canadian River Gas Company transports the fuel from Amarillo Field, in the Texas Panhandle district, to Clayton, New Mexico. Here it is purchased by the Colorado Interstate Gas Company (N. J.), and brought to Pueblo and Denver, Colorado, as well as to other towns along the way. In addition, the Colorado Interstate supplies gas for a line north from Denver to Fort Collins.

And so the natural gas industry has grown. Once a "wild spirit," represented by mysterious pillars of fire that issued from fissures in the earth to terrorize natives, then an incidental by-product of oil drilling, natural gas today not only has found its way into homes in many districts, but more and more is replacing its brothers, fuel oil and coal, for numerous industrial purposes. Glass, ceramic and cement plants, steel mills, brick, lead, enamel ware and vitrified clay manufacturers, oil refineries, power plants, and all other industrial users within reach of existing or projected lines are giving ample illustration of the value of the product.

To what extent new producing areas, further improvements in drilling and transporting technique, and the possibility of mixing natural with manufactured gas for maximum economic usefulness in larger centers may justify extending the web of pipe-lines to other parts of the country, plans already announced and others in formation will reveal in the next few years.

Back to the primitive. In swampy land such as this, oxen and mules have proved to be about the best motive power for transporting pipes for the pipe lines



Photographs courtesy The Pullman Company

Invalids to or from the Mayo Clinic at Rochester, Minnesota, may ride in comfort in this special car

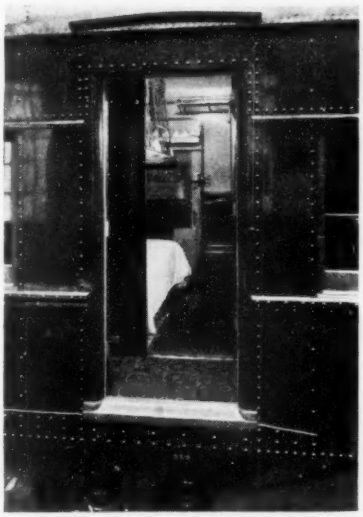
THE SICK MAY RIDE IN PULLMANS

THERE have recently been built, for operation on the Chicago and Northwestern Railway, two Pullman cars specially designed for the comfortable transportation of invalids. These cars will be operated between Chicago and Rochester, Minnesota, home of the famous Mayo Clinic.

Besides the regular platform entrances at the car ends, three doors are placed on one side of each car for the direct entrance of stretchers. These special doorways are 30 inches wide and two of them are so located that a patient on a stretcher may be carried directly into the room he is to occupy; the third provides access to the open-section division of the car. The rooms thus reached are extra wide, and provided with extra wide doors, so that the transfer from stretcher to bed can be made with the least discomfort to the patient.

Each car contains eight open sections, one drawing room, and four rooms; each room having a stationary single bed and an upper berth, as well as folding lavatory arrangements. The upper berth is available for occupancy by an attendant. At the section end of the cars is the lavatory for men, while that for women is at the opposite end.

Particular attention has been given in the construction to eliminating as much as possible the noise of travel.



The side door, 30 inches wide, gives access to one of the private rooms

Diaphragms at the car ends are spring-hung from the top, the arrangement greatly reducing the amount of car-end rattle. Further, rubber insets have been placed between car trucks and bodies at points of contact, to absorb shock and further reduce noise. The cars are also equipped with roller bearings.

Of invalids who require to travel, the proportion who are entirely bed-ridden is small; nevertheless a considerable number are either bed-ridden or require support in getting about; for these latter a short stretcher, really a canvas seat, 30 inches long, has been devised. This stretcher can be easily handled on entering or leaving the car, because the corridors have been widened for the special purpose of accommodating them. In the ordinary car it has often been necessary to remove a window sash in order to permit a person on a stretcher to be lifted in or out.

The third side-wall door, for patients whose space is in an open section, opens into the crosswise corridor which separates the men's lavatory from the aisle between the sections. Thus only one turn has to be made in carrying the patient in or out, and the use of the platform door and vestibule is avoided.

In a number of other details these cars have been arranged to accommodate this special service; for example, electric heating pads are provided. The cars were designed under the supervision of Dr. Thos. R. Crowder, Director of the Department of Sanitation and Surgery of the Pullman Company. They are appropriately named the *Ephraim McDowell* and the *Joseph Lister*, in honor of two men whose contributions to surgical science have been particularly notable. Ephraim McDowell was not only a country doctor, but a country doctor of pioneering days; he practiced in and about Danville, Kentucky, and there, in 1809, successfully performed the first major abdominal operation ever undertaken, for the removal of an ovarian tumor. There in the backwoods, before the days of anesthesia, unassisted, and with only the crudest of facilities, his boldness and skill combined to bring success in an operation of a type which, now commonplace, has since been the means of saving uncounted lives. Dr. Joseph Lister was the English surgeon who discovered and developed the principles of antisepsis.

The loading and unloading of invalid passengers bound for the Mayo Hospital is rendered easy by the side doors which permit the direct transfer of the patient on a stretcher to the car

A typical scene taken during the filming of a talking motion picture. The microphone is the cylindrical object suspended by cords in the center of the set

THE TECHNICIAN TALKS ABOUT THE TALKIES

By RAYMOND FRANCIS YATES

SINCE the silence of the silent drama has been so effectively—or shall we say devastatingly?—broken, much has been said pro and con concerning this new magic of the movies. It must be confessed that, as measured by the box office receipts, "talkies" have, within the startling space of two years, emerged from the state of an uncertain experiment into that of a bombastic success. How deserved this success has been from a purely artistic or esthetic viewpoint, or how lasting it will be is a matter of some conjecture even at this late stage of development. This much may be said, however. The movie makers have, by sheer luck, struck upon a ready-made, ready-to-use idea that has revitalized the whole industry and captivated a public that is still applauding with enthusiasm.

As large as the success of this new idea has been there are many dissenting votes and much disillusionment on the part of movie goers who want their drama on the hoof, and who demand something more dramatically and emotionally substantial than heated bedroom scenes and voices that sound as though they might be produced when noses are clamped with clothes pins. In short, the talkies have not been universally successful and the possibilities of reaching this point will become more and more remote unless our movie manufacturers see more quickly their folly in attempting to produce pictures to meet the fickle demand rather than a standard of artistic perfection. We have seen and heard the talkies in their unpolished nakedness, and now we want stark realism with a ring of real sincerity back of it.

THE movie manufacturers have still much to learn of technical control of sound recording. To put a bald record of voice or music on the sound track of a film or the wax of a record is one thing. To give that record the expansive breath and verve of life is quite another thing. Even a superficial observer of talkie technique cannot help but lament the obvious absence of realism that is so noticeable in the average production. Contrary to what appears to be the established opinion of the critics, the fault does not lie wholly in the technical limitations of the electrical equipment but partly in its manipulation. To draw an analogy: the movie makers are playing a Stradivarius with the technique of a fiddler at a barn dance. In their frantic effort to please a fickle public and to take advantage of a demand that has swept down upon them with unprecedented fury, they have failed to tap the resources of their equipment.

Situated between the microphone in the set and the recording apparatus there is what is known as a mixing panel. Here the monitor listens-in on all sounds passing over the circuit on their way to the wax and photographic film records. This vigil of the monitor is of vast importance for it is he who regulates the degree and intensity of the sound-laden currents passing over the circuit on their way to the "canning factory." The monitor is lord over all that he hears; he may by a twist of his wrist make a whisper out of a call for help, or he may on the other hand make a cough sound like an eruption of Mt. Vesuvius. It is all in the knobs!

At present it is the monitor who is the weak link in the chain. He is all technician when he should be part technician and part artist. He is interested largely in microamperes and the response curves of audio-frequency transformers when esthetic effects and realism should be uppermost in his mind.

SOME months ago the writer was seated in the studio theater of one of our largest producers, reviewing bits of a musical comedy that had recently been filmed. The novices present talked with a learned air about the "highs" and "lows" of the recording, at the same time being serenely insensible to the appallingly bad job of monitoring that had been done in recording the sound. There was a close-up of a young lady engaged in a normal conversation with a friend. While talking, this young lady turned her back to the audience, but there was no change whatsoever in the intensity of her voice. Here the simple turn of a knob might have added a valuable touch of realism for it is obvious that orientation has a pronounced effect upon the voice. During conversation, turning the head affects the volume of the sound reaching the ear of the listener. A small effect, to be sure, but not small enough to lose every vestige of importance. It is going to be through the painstaking attention to these small effects that the movies will eventually emerge into a state of polished and formal art. The paramount question is,

THE motion picture, and now the motion picture in its talkie form, has become such an integral part of the average person's daily life, that any suggestions for improvement take on a personal interest. In the accompanying article Mr. Yates points out some of the failings of the talkies, and how they may be overcome. His technical background in sound work gives the voice of authority to his statements.—*The Editor.*

"When will the talkies learn to talk?" The answer lies with the technicians whose esthetic sense is usually no keener or more susceptible than that of a coal-wagon driver or an ice-man. It is a far cry from the grid bias of a vacuum tube to the artistic niceties that will eventually put more interest in faithful reproduction.

Some of the efforts of our movie makers to produce realistic effects are painfully amusing to one who has any knowledge of the technical considerations involved. There is a scene on the screen showing a canoe being paddled down a stream in an enormous canyon. The canoe is almost an insignificant speck, a dot in the void of a great spectacle of nature. Strange as it may seem, one hears the dip of the paddle. One who knows the making of the talkies can visualize a stage-hand standing beside a tank of water placed under the microphone and dipping a paddle so that the great American movie audience will be treated to a bit of realism. The whole scene was incongruous enough to make a school boy laugh.

Realism in talkies will not come as an over-night development. It is something that must be fathered, something that must be nursed, something that must grow out of a multitude of unpardonable mistakes. It is something that must be first felt and then learned. However, when one considers that we have had nearly three years of unrestrained talkie making, one is inclined to believe that the perfection of realism has not been as rapid as it should have been. Let us take another example of bad talkie making.

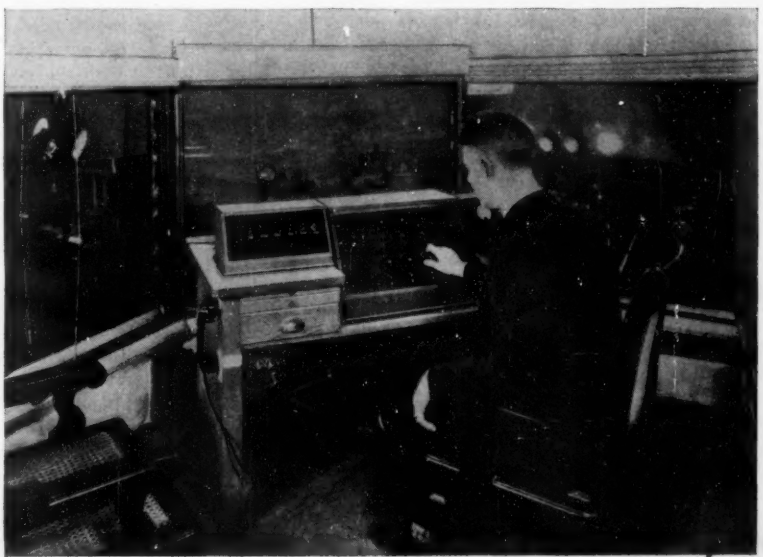
THE scene is a living-room. There is a normal conversation taking place between the occupants. The recording is, on the whole, fairly good. There is a quick flash to the platform of a railroad station. A locomotive with a string of Pullmans rushes into the scene and stops. The effect is terrible. What has happened? The sound produced by the approaching locomotive, a locomotive that one would think almost knocked the tripod from under the camera so closely did it approach, had a volume that was not much greater by comparison than the voices that immediately preceded it in the living-room set. The effect was strikingly incongruous. There was no dramatization at all. The locomotive should have thundered into the scene with a rattle of monstrous iron wheels, with the screaming of brakes and with the glamour and noise that always attends the approach of such gigantic pieces of mechanism. This particular locomotive really almost whispered its way into the scene.

It might be confessed here that the technical equipment in present use is not designed to handle the recording of an approaching locomotive the way the recording of an approaching "he" locomotive should be handled. There is some question as to whether or not this terrific high level of sound intensity could be passed through the amplifying tubes. The question arises: "Why would it not be possible to arrange an automatic switching in of additional amplifying equipment and additional horns so that the whole theater would resound with the thunder of the great iron horse?" It is true that sound amplification, when the sound takes the form of noise, can be amplified to a tremendous extent without the audience becoming at all aware of any distortion. When the sound of an orchestra is recorded the engineer must take care to keep the mould of distortion cut away but when he is recording noise such as the eruption of Mt. Vesuvius or a battle scene, the "sky is the limit." Perhaps we may look forward to the day when locomotives will be locomotives and battle scenes will sound more realistic than Boy Scout Troop No. 125 having their annual outing.

At the present time it is the general practice to place the ear of the "talkies," the microphone, in the center of the set. The technical reasons for this practice have never been made quite clear to the writer. Would it be unreasonable to assume that the microphone, representing as it does the ear of the audience, should be placed at the front of the set in a position bearing the same relation to the performers that the audience bears to the screen? With the microphone assuming this position it would appear that a portion of intelligent monitoring might, to a certain extent at least, be automatically solved.

A still more glowing example of bad manipulation of equipment was recently made obvious when a performer entering an extremely deep set from the back, walked into a close-up as he talked. The monitor had made no effort to fade him in. The sound effects were distinctly displeasing and somewhat incongruous when one realized that a sixty thousand dollar oriental rug adorned the floor and the room was furnished with a carload of expensive trappings fit for kings. There is no expense to which a well-managed studio will not go when it comes to supplying the necessary furniture and equipment and scenery for a major production. It makes one wonder why the smaller details of sound recording are permitted to pass by practically unnoticed.

IT would seem that sound recording is now in the same state of perfection that photography was in 15 years ago. This sorry state of affairs has been brought about by giving the technicians, the sound engineers if you will, too much of a free hand at the studios. Their judgment is in no case tempered with artistic sensitiveness; they cannot see the woods for the technical trees. They are interested in curves and technical precision and they have quite forgotten that technical precision is a far cry from artistic realism. It matters not to the man in the audience whether a tube is biased correctly or whether a resistance deviates one watt or 50 watts, he has come to the theatre to see life lived on the screen, to see an illusion that will be so perfect as to cause him to forget about his daily troubles, his trials and vicissitudes, and the sooner the talkies can deliver this message to him in the true, unvarnished voice of life, the sooner the talkies will be here to stay.



The monitor operator sees all and hears all. He should be part technician and part artist, for by a twist of the wrist he can improve or mar a sound record

Courtesy *Nature Magazine*

A herring gull in full flight showing the slots of its wings opened

A sailing kingbird flying slowly. Primary feathers are outstretched but the false wings forming slots are barely visible

BIRDS HAVE NATURAL SLOTTED WINGS

By RAY P. HOLLAND, Jr.

SLOTTED wings seem to be one of the most recent of the greater aerodynamic developments. It has been in comparatively recent years only that they have been used to any extent at all. As they are used on the airplane, they seem to be one of the man-made devices which have no parallel in nature. There are many such things that appear to have been developed entirely in a scientific laboratory or as the result of continual development of complicated theories. When the result is finally reached and the product is finished, the general opinion is that something entirely new has been made. Then, suddenly, it becomes known that the identical thing that man has worked so hard to attain has existed all the time in a rather simple and surprisingly perfect application in nature.

Slotted wings are an excellent example of this. In nature they are almost as old as flight itself. The earliest flying creatures had no feathers. They flew with a skin web as the supporting surface, as does the bat. With the development of feathers, the primitive slotted wing appeared. That which corresponds to the fingers of our hand became the long, stiff feathers that form the wing-tip of the bird. The thumb developed, on the bat, into a projection to aid it in clinging to walls. On the bird, it became what has been known as the "false wing" or "bastard wing."

The false wing consists of a small group of long, stiff feathers above the leading edge slightly less than half the distance to the wing-tip on most birds. In its normal position, it fits into the conformation of the wing so well that it is not easily seen. When open, it is plainly visible. Being directly in front of the more flexible portion of the wing, it is in a perfect position to direct the airflow over the lateral control surfaces. Thus, in its function it is like the airplane slot.

The manner of operation is slightly different. Naturally, because of mechanical reasons, the bird can not open its slot directly to the front as on the airplane. The means it uses is to move the tips of the slot feathers forward and downward with the joint where the group connects with the wing proper as the pivot. The portion of the wing left exposed by this motion is very well shaped to produce high lift. The feathers of the false wing are disposed so that the cross-sectional shape of the airfoil they form is easily altered. When the slot closes again, the feathers shape perfectly into the wing. It is the ability to change shapes and areas at will that gives the bird such a remarkable control of its flight.

The primary feathers that form the wing-tip of a bird have an aerodynamic action somewhat similar to that performed by the bastard wing. The quill of these feathers is close to the front edge. Each feather is an airfoil in itself. They are arranged so that in overlapping, the leading edge of one feather is above the trailing edge of the feather in front of it. The nearer the end of the wing they extend, the more they diverge, until before the tip is reached, there is space between the individual feathers. The effect is that near the wing-tip there are several airfoils at high angles of attack, one behind the other, the whole group forming one large airfoil. Although not exactly like a multi-slot wing, this arrangement probably has some similar characteristics.

IT is likely that the tips of the primary feathers, which are free to twist over certain limits, place themselves in positions with negative angles of attack when the bird is in certain attitudes. This would form a true multi-slot wing. Mechanical difficulties prevent man from using such a wing, although he understands its action perfectly. This type of wing using numerous slots has been tested in a wind tunnel up to over 40 degrees angle of attack without reaching its "burble" point. The bird probably makes use of the principle in landing and in slow flying. At that time, the tip feathers are spread wide. In rapid climbing, maximum lift is obtained in the same manner.

When high-speed level flight or a dive is desired, the bird's wing-tip moves to the rear in relation to the rest of the wing; folding closes the openings between feathers. In addition to closing the slots, this action furnishes a desirable sweepback. Moving a supporting surface to the rear will move the center of pressure in the same direction and steepen the dive. In extremely rapid dives, birds fold their wings until they are scarcely stubs on the sides of the body. In this means of airfoil modification, natural flight has one of its greatest advantages over artificial flight.

The very shape of the wing-tip feathers is strong evidence that they act as individual airfoils. They are flat and of practically uniform chord out to the point where they are spread wide enough to cause a space between them when the wing is spread. At that point there is a sudden tapering of the plan form. The part of the feather in front of the quill narrows down almost to nothing. The feather becomes an efficient airfoil instead of only a component in an arrangement that makes up one large surface. The cross-sectional shape of these feathers is usually similar to that used on our racing planes, but even thinner. It is so thin, in fact, that it would not be practicable to construct an airplane wing using the same proportions.

As an example of a bird which uses its slotted wings to great advantage, let us consider the wild duck. Certain species of them migrate from as far north as Alaska in the summer and southward to the Gulf of Mexico in the winter. When not disturbed, they prefer not to fly, unless they have a certain destination. In their flight to that destination, they travel in a straight line at a high speed. When disturbed, they must be able to climb almost vertically for their protection. Also, they possess a marked ability to change direction and speed suddenly when they see something that arouses their suspicion.

Suppose that an order should be received in an aircraft factory for a ship of very high wing-loading, the nearest thing possible to a racing plane, that would have a low landing speed, an ability to stunt, extremely good climb, and also be capable of long-range nonstop flights. It would be absurd to try to fill all the specifications in a single ship. Any one of the requirements could be fulfilled in a specialized job for that purpose, but no individual plane could possess all the qualities necessary. Nevertheless, a duck can do all those things.

After flying all night at a high altitude, the duck reduces its wing area to almost nothing, shifts its center of pressure to the rear, and begins a long bullet-like dive to just above the surface of the water. At that point, it increases its wing area and resistance at the same time. As its speed diminishes, the false wing moves forward from its position to form the slot. It maintains perfect lateral control up to the point when it becomes practically motionless in the air only a few inches over the water. Then, with a few flaps of the wings, it lets itself down easily. If it is disturbed, it springs from the water with amazing alacrity. A rapid and steep climb is maintained until the bird is out of danger. During this climb, the slots are continually open. They are, more than any other one thing, responsible for this performance. They increase the lift and prevent "burbling" in the attitude necessary for the climb.

DIFFERENT birds, depending on the degree to which they use them, have slotted wings developed to different degrees. Generally, the false wing is comparatively small on gliding birds. They are slow fliers that employ extremely efficient airfoils. Birds such as the albatross derive their efficiency from a supporting surface of very high aspect ratio. Their light wing-loading provides a sufficiently slow landing speed for them. Great climbing speed is unnecessary because they fly over level stretches of water with only slight changes in elevation. Their continuous gliding is made possible by the rising currents of air caused by the swells of the sea. Birds utilize these slopes of water in exactly the same manner that a sailplane uses a long gradual hillside.

Those birds which have a high-speed flapping flight have the slots developed to the greatest extent. They are birds of very high wing-loading. High-speed wing action is necessary in order to maintain flight. Nevertheless, a remarkable rate of climb and a reasonably slow landing speed can be produced. Quail, grouse, and pheasants are birds of this type. Examination shows that these birds have abnormally large bastard wings.

I have noticed that the position of the slot varies on birds of different sizes. To illustrate this, I will compare the Hutchin's goose, which weighs about eight pounds, to a representative small bird. The center of the group of feathers, on the goose, that constitutes the bastard wing, is approximately 58 percent of the distance from the body to the tip of the wing. On the smaller bird, it is only 37 percent of the distance out. The smaller bird's false wing occupies slightly over 20 percent of the leading edge, while that on the goose occupies only 17 percent of its leading edge.

HOWEVER, this latter comparison creates the wrong impression because the goose is a bird of high aspect ratio while the other is not. The slotted wing area of the goose is much larger in comparison to the entire wing area than is the case on the other bird. Its wing-loading is considerably greater also. The manner of flight, in the same way that it affects the size, is likely to have a direct bearing on the position of the false wing.

On the ruffed grouse, a bird of heavy wing-loading that flies with an extremely rapid wing action, the slot feathers are very close to 50 percent of the distance to the tip. On birds of light wing-loading it is usually less than half way out. These observations indicate that the bastard wing, viewed from a standpoint of size and position only, has a direct relation to the size and flying characteristics of the bird, and must be a part of its control system, and not merely a useless appendage.

If you would like to see a practical example of the actual means the bird uses to open his slotted wings, it is only necessary to obtain a bird's wing to experiment with. This should be easy, for there are many species of detrimental birds, such as the hawk or crow, that may be killed at any season. The wing of the bird, cut from the body, is all that is needed. There is a tendon just in front of the wing bone. As this is pulled the wing starts to unfold. Everything goes on normally with the false wing in its original position until the maximum wing area is reached. In landing, the bird would employ this position of its wing in order to have the lightest wing-loading, and consequently the slowest landing speed. It is also in landing that it makes the greatest use of the slotted wing. It is, therefore, logical that the action of the false wing should be governed by the tendon that holds the wing outstretched.

By pulling with slightly more force on the same tendon, the false wing will move forward and downward into its correct position to act as a slotted wing. When actually seen operating in this manner the function of the so-called bastard wing is very evident.

ACTUAL photographs showing the slots open on flying birds form the only more convincing evidence I know of. It is difficult actually to watch birds and see the system in operation, even with binoculars. The opening is slight and there is only a short period of time during which to observe it. It may be seen after much effort but not distinctly enough to be a proof. However, to take a wing in your hand and actually make the slot open, will make even the most stubborn doubter stand convinced.

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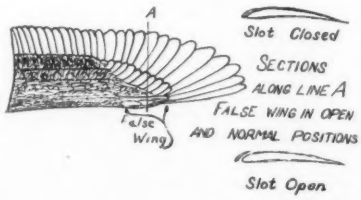
Instruction in "blind" flying is becoming increasingly important to the aerial transport industry. An article telling how it is carried out is scheduled for early release.



Goose wing showing similarity to airplane slotted wing arrangement

Left: **Comparatively small false wing on slow-flying, soaring bird**

Right: **The sudden tapering at the point where the primary feathers begin to act as individual airfoils**

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

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NOW YOU CAN BUY INSECTS FOR 10 DOLLARS A MILLION

TEN dollars a million for insects! Who'll buy? The average stung, bitten, and be-itched picnicker or camper may ask wearily why anybody should want to buy a million insects at that price when you get

Recently developed safe, fireless lamp for flashlight photography

more than a million for nothing every time you show your nose out of doors.

But the insects that are worth 10 dollars a million are cheap at the price, for they prey on the eggs of other insects, thereby preventing the pests from ever seeing the light. They are the almost microscopic wasps known as *Trichogramma*, which are reared in captivity by Stanley E. Flanders, entomologist of the Citrus Experiment Station at Riverside, California. Mr. Flanders has been at this work for some time now, and has improved his rearing methods to a point where the tiny parasites can be produced at a thousand for a cent. They are shipped out in great numbers to orchardists, who release them to assist in their endless warfare on fruit-spoiling insect pests.—*Science Service.*

NEW PHOTO FLASH LAMP

A FIRELESS, smokeless, odorless, and noiseless photographic flash lamp has been developed by the incandescent lamp department of the General Electric Company, Cleveland. The flash is confined entirely within a bulb, with resulting advantages that are expected to revolutionize flashlight photography. Requiring only one-hundredth of a second to act, and being without hazard, it will make possible the taking of flashlight photographs in places heretofore practically impossible to "shoot," such as in trains, airships, and theaters, under water, and by insurance companies requiring night photographs under all weather conditions.

The lamp consists of a clear bulb of standard design, with the flashlight filament coated with a special preparation, and with a quantity of very thin aluminum foil in crumpled sheet form within the bulb. The bulb is oxygen-filled.

When the circuit is closed the filament is lighted and this, in turn, lights the foil. The lamp operates on any 115-volt house supply, or with dry, storage, or flashlight batteries. A new lamp is needed for each flash. The lamp is most efficient when used with suitable reflector equipment.

NEW PROCESS FOR CARBON BLACK MANUFACTURE YIELDS HYDROGEN

THE production of carbon black from natural gas has been, heretofore, a wasteful process, but experiments carried out by the United States Bureau of Mines give promise of an increased yield of more than 400 percent.

The old method, and the one in widest use, consisted of burning natural gases incompletely and collecting the unburned carbon on cold metal surfaces when the gases passed off. Sometimes the carbon black was collected by filtering the gases through cloth.

The new method calls for the passing of the gases through ignited coke. The coke is fanned to great heat by subjecting it to a forced air draft, after which the natural gas is passed through it and cracked.

An advantage to be gained by the new process is that, in addition to the carbon black, hydrogen may be recovered and used in some localities for the synthesis of motor fuel and the manufacture of ammonia and other products.—*A. E. B.*

DOUBLE-SPIRAL CONVEYOR

A NEW portable, flexible, power-driven, elevating and tiering conveyor has just been introduced and has already found many useful applications in a wide range of industries.

The TwinVeyor, as this new apparatus is called, uses a new principle: two external spiral tubes are turned toward each other by a power head. Anything placed on the conveyor travels forward rapidly, perfectly balanced. It is used for handling raw materials and finished products in bags, bales, and bundles. The equipment finds other applications handling crates and boxes, and experiments are being made handling the finished product itself, without packaging, where its shape and size permit the spirals to get hold of it. It carries bagged sugar

Double spiral conveyor for bags and bales. It is motor operated

up a 30 percent grade at the rate of 90 feet per minute, handling 1800 bags per hour.

A standard unit consists of six eight-foot dual sections and a power head which draws current from any power line. Each section joins to the assembly with an auto-

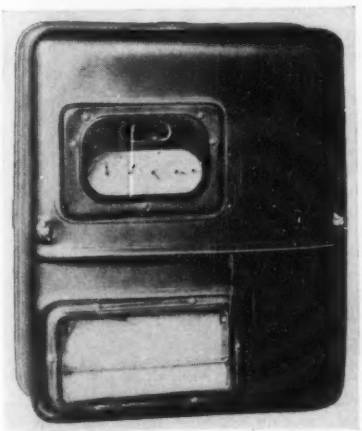
matic lock. It is easily shifted about by one man and the entire 50-foot line can be assembled or disassembled in six minutes. Flexibility is secured by the ability of any joint to take a 15 degree angle horizontally, 15 degrees up or 10 degrees down.

A hurdle section permits any number of TwinVeyor 50-foot units to be hooked together, forming a continuous line of any desired length. The traveling load hurdles each power head in the line. Right and left spiral chutes are provided for shunting the load from one TwinVeyor line to another without manual handling, thus making right-angle turns simple.

MEASURING ULTRA-VIOLET RAYS

THE element of danger in the indiscriminate use of the ultra-violet ray has had to do with the dosage, the amount of exposure, the proper measuring of ultra-violet radiation for the purpose at hand. It has heretofore been a difficult task to measure this amount exactly, but now there is an ingenious device for the purpose, an ultra-violet ray meter that records the amount of ultra-violet rays coming one's way as accurately as an electric house meter gives the amount of electricity one is consuming in the home.

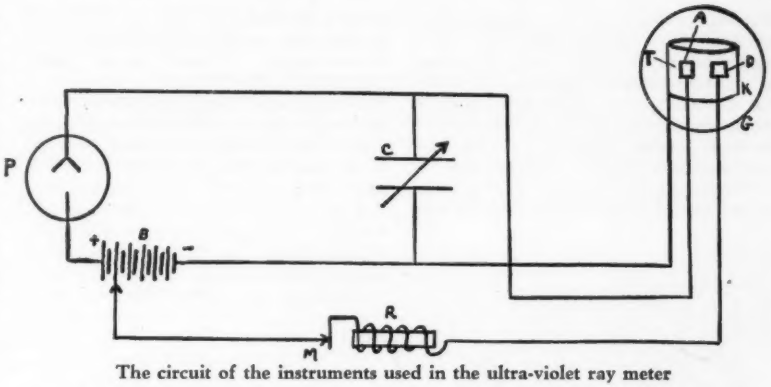
This indicator operates from dry cells within it. Its essential element, the "eye" of the instrument, is a photo-electric cell which was developed by Dr. H. C. Rentschler of the Westinghouse Lamp Company. The cell in this case is sensitive only to those light rays supposed to have therapeutic value or other effect on vitality—rays .0029 to .0031 millimeters in wavelength. The cell itself is the result of research findings that: (1) By a proper selection of the active material, a cell may be obtained that will not respond to light of longer wavelength than that desired; and: (2) By use of proper light filters it will not respond to light of shorter wavelength than that suitable for the purpose. (A cell



Graphic meter for recording the quantity of ultra-violet on a chart

of uranium metal and Corex D glass, for example, responds only to that band of light used in prevention and cure of rickets.)

When the rays strike the cell of the meter, a certain amount of current passes through it, proportional to the intensity of the rays, and charges a condenser which, when fully charged, trips a counter. The operation is then repeated, each impulse measuring a definite quantity, irrespective of the light intensity. Since the unit of measurement has at present no name, the value taken is arbitrary. Over a given period of time the number of impulses per minute, each accompanied by a "click," thus indicates intensity, while the total number of impulses indicates quantity.



The circuit of the instruments used in the ultra-violet ray meter

The principle on which the meter operates is as follows, referring to the diagram: A battery B charges condenser C at a rate determined by photo-electric cell P when light falls upon the cathode. Glow tube G has metal cylinder K for cathode and a primary anode A and main anode D. A small gap exists between A and cathode at T. When C is charged to a potential such that a discharge takes place between A and K, the cathode resistance of the glow tube is broken down and current flows between D and K. This operates the relay R, registers the count, and opens the main circuit M. The condenser is discharged simultaneously. The operation is then repeated. The total quantity of light falling on P is proportional to the total number of discharges registered.

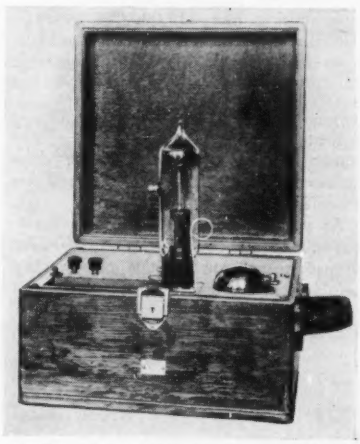
WOOD ALCOHOL

WITHIN recent years it has become possible to produce synthetically the wood alcohol that was formerly prepared only by destructive distillation of wood. The substance is now manufactured from water-gas and hydrogen at a cost which makes it possible to produce large quantities at a low price. Modern industry is, therefore, attempting to introduce the substance for a large variety of purposes, including its use as an anti-freeze mixture in automobile radiators. It is also used in the manufacture of quick-drying shellacs and varnishes. It has long been known that wood alcohol is a dangerous poison with cumulative effects. When taken frequently in small doses, it produces blindness; in large doses, it causes death. The added danger from this product is in the fact that the repeated inhalation as well as the drinking of very small doses of the poison may produce the most serious results.

If this substance is to be used as an anti-freeze mixture in the coming winter, employees of garages who will inhale large amounts of it from overheated radiators are likely to suffer serious injury as a result.

Cases have already been reported in which women and children who have used quick-drying shellacs or varnishes, made with methanol, in closed rooms have suffered harm as a result. In the great spray process used in automobile factories, the spraying is done under hoods and employees wear masks, so that they are protected against the hazard.

As is usual in modern industry, the name of the product has been concealed by the bestowing of fanciful names and the average person does not recognize under the name *methanol* or some other fanciful title the old, old hazardous wood alcohol.—*M. F.*



Ultra-violet indicating meter which uses a special photo-electric cell

FEATS OF SHORT WAVES

RADIO waves which will do the family cooking, provide wireless illumination for homes, alleviate pain, and cure disease are the goal of new investigations into the possibilities of the short-wave high-power vacuum tube, according to Dr. Willis R. Whitney, director of the General Electric Research Laboratories, in a research narrative issued by the Engineering Foundation.

Control of this power for practical uses will immediately open up lines of advance in industry and therapeutics hitherto closed to science, it is stated. Simplified mechanisms and a reduction in the cost of producing large volumes of radio energy are the problems now facing solution.

Radio cooking has already been demonstrated in tests with the new tube.

"A wire was suspended over a table,"

Dr. Whitney states, "at a distance of a few feet from the radiating aerial, which was a copper bar about 10 feet long. A sausage in a glass container suspended from the end of the wire was soon cooked. Likewise an egg was 'fried' in this container, and an apple spitted on the end of the wire was thoroughly baked in a short time.

"With suitable changes of utensils, cookies were baked and water boiled. There were no flames or other visible evidences of heat accompanying the cooking. The vacuum tube from which this weird power emanated was only two feet long and five inches in diameter.

"As yet the high-power short-wave vacuum tubes are being used for experimental purposes only. To bring them into practical usefulness at reasonable cost and discover their many possibilities for service to mankind is now our task."

Robert P. Robinson of the Skelly Oil Company, found this stone at San Angelo, Texas. Its resemblance to a human skull is striking, but since it came from rocks of the early cretaceous period, thus making it something like 115,000,000 years old, scientists are not inclined to take its human origin at all seriously

BLOOD PRESSURE

THE blood pressure of human beings is measured by putting an elastic cuff around the arm, inflating it with air, and then listening to determine the points at which the sound of the blood in the vessels is extinguished and the point at which it again appears when the pressure of the cuff is released. This simple test has been of tremendous importance, particularly in examinations for life insurance. A normal blood pressure is recognized as being approximately 120 millimeters of mercury. Insurance companies insure persons with pressures ranging from 100 to 140.

In order to make some more exact determinations regarding blood pressure of a considerable group under controlled conditions, Drs. W. C. Alvarez and L. L. Stanley took the blood pressure of all of the prisoners in the San Quentin prison in California. They are inclined to believe that there is a normal blood pressure for each person; that if a person has a high blood pressure at 20 years of age, he is likely to have a high pressure at 40. The lower limit of normal pressure they found to be 90 millimeters of mercury and the upper limit 140. They found the normal pressure about 115, which is lower than the figure usually found for men out in the world. The reason for this they consider to be the fact that the prisoners are not fatigued and worried by the struggle to make a living. They did not find that alcohol affected the blood pressure, but tobacco appears to raise it about 4 millimeters.

Men who have been convicted of murder in the first degree showed a blood pressure slightly higher than that of other prisoners of the same age. They found that the prison guards had a pressure considerably higher than those of prisoners, which they consider to be due particularly to overweight, and also to the fact that the guards were applying for positions at the time when the pressures were taken and that many of them were anxious for fear they might be rejected.—*M. F.*

POTATO RUBBER

THE Firestone Tire and Rubber Company is experimenting on the commercial value of a new variety of rubber with potato starch as the base. The synthetic product contains no latex or plantation rubber. It is made by mixing the starch with chemicals which coagulate it into a gum-like substance differing from rubber only in that it is less elastic.—*Barron's.*

REFRIGERANTS FROM THE TROPICS

"YOUNG as we are," says Dr. H. E. Howe, editor of *Industrial and Engineering Chemistry,* "we can remember the days when sailing vessels carried cargoes of natural ice from Maine to Cuba, and we believe even as far as Calcutta. How times have changed!

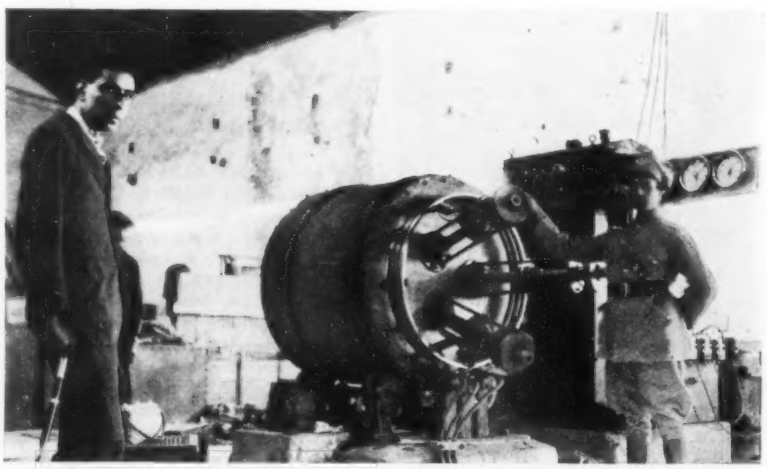
"There is now en route to New York from Mexico one of three vessels, each of which has been equipped with a compartment insulated against heat exchange by 12 inches of cork board to bring solid carbon dioxide to the metropolis for refrigerating purposes. One of the petroleum companies in drilling for oil struck a supply of carbon dioxide which rushed to the surface at a pressure of 1000 pounds.

"It is much too early to discuss the economics of this venture. Inasmuch as the solidified gas must be cleaned of its impurities before it can be re-made into commercially pure solid carbon dioxide, it is doubtful whether the natural high pressure will be of much advantage, and undoubtedly there have been some nice technical difficulties in the purification of this particular supply of gas. We have yet to learn, too, with what efficiency and what percentage of loss the solid gas has been stowed in the hold, transported, unloaded, and distributed. These are technical details concerning which no information has so far been made available. However, the whole venture is intriguing. The mere thought of preparing a refrigerant in the tropics for shipment into the temperate zone is so complete a reversal of the old established practice as to afford another example of how chemistry is helping to remake the world."—*A. E. B.*

NEW INSECTICIDE PRODUCED BY "CUBE ROOTS"

IT used to be a favorite wheeze at college to suggest to the room-mate who had prematurely squandered his allowance that he write home for funds with which to buy a cosine for use in mathematics class. We used to assume that Dad either had never been exposed to trigonometry or had forgotten that a cosine was merely a mathematical function of an angle and that he would "enclose check" rather than admit ignorance. We were forcibly reminded of that ancient practice by a recent statement in a publication of the staid United States Bureau of Agriculture, when we noticed the sentence "cube roots are not yet available commercially."

We still think Dr. R. C. Roark, of that department, had his tongue in his cheek as he wrote that sentence, but further investigation revealed the fact that "cube" is a South American plant and like most other plants, it has roots. (The plant's name, incidentally, is pronounced koo-bay.) In the course of this reading, we learned further that the cube plant has been found to contain a substance called rotenone which has been found to be an excellent insecticide. The Department is therefore urging the Malay States to grow rotenone-bearing plants on a commercial scale for



Even turbulent Afghanistan, where kings are made and unmade overnight, must have coins. Here is shown the electrical smelting machine, imported from America, which has just been installed in the mint at Kabul, the capital. Beside it stand an army officer and a modern young Afghan "intellectual"

American trade. This new insecticide is found in quantities up to 7 percent in the root of the South American cube plant, up to 5.5 percent in derris roots, and to a lesser extent in three other plants. The cube plant now grows in a part of South America where the climate is similar to that of the Malay States and surrounding countries.

Tests by the Department of Agriculture indicate that rotenone is highly poisonous to both sucking and chewing insects. In tests conducted privately, rotenone was fed to dogs, cats, sheep, and chickens in quantities up to 1 grain per pound of body weight and no injury was noticeable.—*A. E. B.*

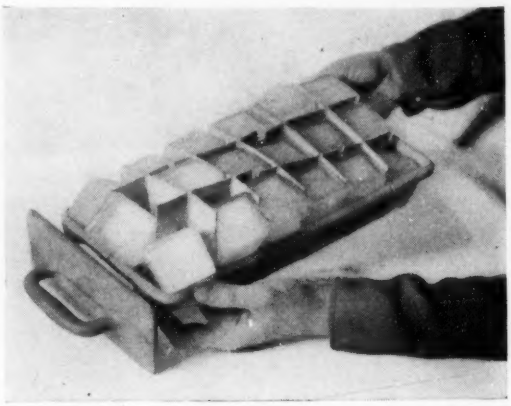
KETOGENIC DIET IN EPILEPSY

IN 1921 it was suggested that children with epilepsy might have the number of their attacks greatly reduced by providing them with a diet low in protein and containing large amounts of fat as compared with the amount of sugar taken into the body. This is called a ketogenic diet, because it tends to produce an excessive amount of ketones and their derivatives in the blood and in the excretions. The diet must be carefully watched, since an excessive amount of this substance produces serious symptoms.

Recently, Drs. Henry F. Helmholz and H. M. Keith have recorded the results of this diet on 272 children who had suffered with epileptic attacks. Two hundred forty-three children with epilepsy of unknown origin, in that the attacks could not be related to any disease or surgical disturbance, were treated by this diet. One hundred seventy-one of these children cooperated fully. One hundred forty-one children had been on the diet more than a year and 30 had been treated less than a year. Of the 141 patients treated for more than one year, 43 patients had remained free from epileptic attacks from one to seven years, and 32 others had shown definite improvement, as evidenced by the decided improvement in the number and severity of the attacks and by improvement in their general demeanor.

It has been argued by some observers that dehydration of the body is an important factor in the lessening of the convulsions. The investigators admit that this plays a part, but do not believe that it is the only factor.

Apparently 30 percent of the patients with epilepsy of unknown origin are freed from convulsive seizures by the use of this diet and, under completely controlled conditions, as many as 37 percent may be relieved of their disturbance. It is, of course, impossible to keep such children in hospitals over many years, and it becomes necessary for parents in the home to learn how to handle the diet and to take care of the child properly.—*M. F.*



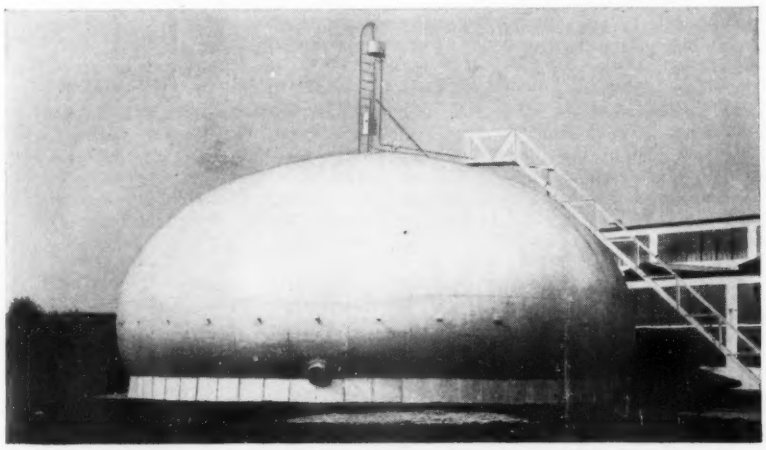
Ordinary ice cube trays of automatic refrigerators are unsatisfactory because it is difficult to remove one or two cubes without emptying the tray entirely. A flip of the finger, however, is all that is necessary to remove just the number wanted from this new tray developed by the Frigidaire Corporation. It is made of strong rubber on a rigid steel rod frame

CHEMICAL PARADOX LEADS TO BETTER INSULATED WIRE

RUBBER is a non-conductor of electricity. Carbon black is a conductor. Therefore, it would appear natural that the admixture of carbon black in rubber would increase the latter's conductivity. In fact, this has been generally assumed to be the case until W. B. Wiegand and C. R. Boggs, in a recent issue of *Industrial and Engineering Chemistry* disclosed experimental evidence to the contrary. As a matter of fact, up to about 10 percent, by weight, of properly made and dried carbon black may be added to each 100 parts of rubber hydrocarbon present in rubber insulating compounds with marked improvement in dielectric strength, resistivity, and power factor, and without serious increase in dielectric constant of the rubber insulation.

The exact amount of carbon black required depends somewhat on which electrical property is to be brought to its maximum value.

This discovery is of importance to the makers of insulated wire who use a rubber covering next to the metal. In fact, these results would seem to render advisable the rewriting of many specifications dealing with rubber insulating compounds, and thus make it possible to apply the well-known beneficial effects of carbon black compounding—improved toughness, density, wearing resistance, imperviousness to light, tear resistance, and so forth—to the electrical insulation field, from which it has hitherto been barred.—*A. E. B.*



Looking like a huge drop of water on some oily surface, this Hortonspheroid holding 10,000 barrels of oil, was built for experimental purposes at Chicago

NEW OIL TANK HAS UNIQUE SHAPE

IF you were to visit certain oil company properties in Texas you would see unusual steel structures which have the appearance of giant mushrooms breaking through the ground. They are a new type of storage tank designed by the Chicago Bridge and Iron Works.

The Hortonspheroid, as this unusual shaped tank is called, is used to store high-test gasoline and other volatile oils. Such liquids are placed in the tank and the tank closed tight to prevent evaporation loss taking place.

It is possible to close the Hortonspheroid tight because it is designed to withstand a certain pressure, usually 10 or 15 pounds per square inch. As the temperature rises, the pressure increases but no vapor escapes. Each installation is, of course, equipped with a safety valve.

But why the unusual shape? It is simply the shape which a flexible container would take if filled with liquid and subjected to a few pounds pressure. It is the most natural shape for such conditions and, by the way, the most economical one, as all of the metal used in its construction is used effectively.

SWORD SWALLOWERS

THE sword swallower is able to pass a long knife down his throat by developing a special agility in the movement and by developing also the ability to breathe by movements of the ribs without moving the diaphragm. That fact was recently determined by three French physicians who subjected two sword swallowers to a

Seated within the cabin of a large airplane, the young lady above wears the parachute harness which is covered with a velour jacket. At right, she has snapped the simple parachute hook into the harness ring

physical examination, using both the X ray and the esophagoscope, an illuminating device which enables the physician to look into the tube through which food passes when swallowed.

The use of this device, the esophagoscope, revealed the fact that there were no special abnormalities of the esophagus nor was its lining full of scars as might have been the case if the swords had cut it. The evidence indicated that the sword is passed down by making a straight line through the mouth, throat, and esophagus, and that cutting is avoided by holding the diaphragm still in the manner that has been mentioned. In order to be a sword swallower one has to be especially built as well as trained for the purpose.—*M. F.*

A QUICKLY ATTACHABLE PARACHUTE

WITH more and more travelers using aerial transportation, the question of parachutes for passengers in cabin airplanes becomes increasingly important. The Russell Parachute Company has developed a quick attachable parachute which promises to be most useful.

The passenger wears a harness covered by an attractive velour jacket. The velour-faced parachute pack is placed conveniently in a metal rack. The pack can be instantly removed from its rack, grasped by the hand holds on either side and with one quick movement engaged to the single steel hook in the harness breast plate.

The pack is in no wise different from the ordinary Russell 'chute and acts just as efficiently and dependably.—*A. K.*

A ROTOR AIRCRAFT

RECENTLY *The New York Times* published an interesting story on a "rotor aircraft," a photograph of which we reproduce here.

Piecing together the newspaper story and what we can deduce from the photograph of the craft (built mysteriously on a barge moored in Long Island Sound off Mamaroneck, New York) we analyze it as follows:

In the center there is a short fuselage or nacelle in which there are: a tandem cockpit; a Wright Gipsy, 90 horsepower, air-cooled engine used to drive the rotors; and at the front end, another engine driving a conventional tractor propeller with three blades.

The nacelle is mounted on a conventional twin float alighting gear (built by the Edo Aircraft Corporation).

The tail surfaces are not mounted at the end of the nacelle, but are carried by booms and outriggers.

The front engine and propeller constitute

the propulsive system, differing in no wise from the ordinary propulsive system.

The Wright Gipsy engine, by some species of gearing keeps two large rotors in movement, one on each side of the fuselage. These rotors have a combined span of slightly less magnitude than would be the normal span for a seaplane of this size. The rotors are two feet in diameter and carry sheltering circular disks four feet in diameter at their ends.

At the time of the Flettner visit to America in his rotor driven ship, *Buckau*, there was much speculation as to the possibility of employing a rotor as the sustaining element of an aircraft. Theoretically, there is nothing impossible in this. When a cylinder is rotated in an airstream it experiences a side force of considerable magnitude. The principle of this side force was discovered by a German scientist by the name of Magnus more than 60 years ago. The Magnus principle explains the swerve of a baseball.

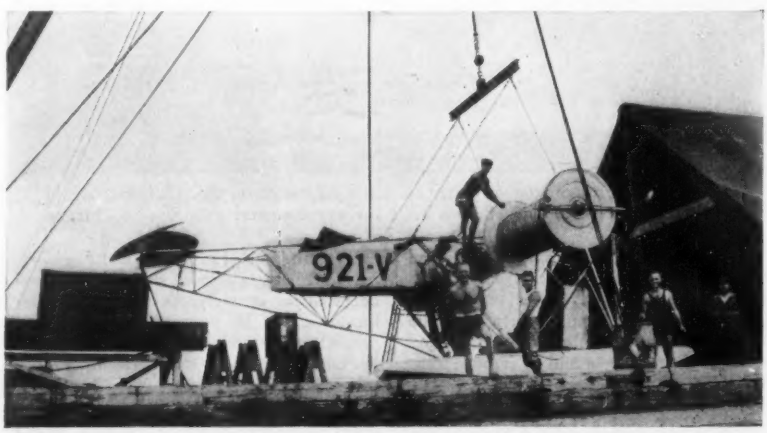
If the rotor aircraft is set in forward motion by the pull of the tractor propeller, and the cylinders are rotated so that the upper side is moving into the wind, the force acting on the lower side becomes a vertical or lift force.

For the same projected area of rotor, it is possible to obtain several times the lift of an ordinary wing—perhaps seven or eight times as much. Therefore the projected area of the rotor can be considerably smaller than the area of the equivalent airfoil and it is conceivable that for the same gross weight a more compact sustaining system can be used.

There are, however, two great difficulties to overcome. The ordinary airfoil, when the engine fails, acts very well in a glide. If the Gypsy engine should fail, the rotors ceasing to rotate would be deprived of lift and the craft might fall very rapidly. The other difficulty is one of efficiency. From experiments made by the writer of this note, it would appear that even when a long slim rotor is employed, and large sheltering disks are placed at the ends, the lift-over-drag ratio—the ratio of sustaining force to resistance of the rotor—is only five or six. For a good airplane wing, this ratio of lift to drag may be as high as 20. Therefore high speed and efficiency become difficult of attainment with a rotor as the sustaining element. It is clear that no rotating lifting element can be as efficient as a beautifully cambered wing. Perhaps the mysterious designers are perfectly aware of these facts and have already met the difficulties by advanced research. We shall await further news with real interest.—*A. K.*

GROOMING THE *DO-X*

THE Dornier *DO-X* is being actively prepared for its forthcoming flight across the Atlantic to the United States. Since its initial flight, the giant flying boat has undergone a number of important changes. In its early form, the power plant consisted of 12 air-cooled Jupiter engines



Wingless airplane, an adaptation of the Magnus principle on which Flettner's rotor ship operated, on the barge on which it was built in Long Island Sound

of 475 to 500 horsepower each. The air-cooled engines were disposed in tandem in six nacelles. Some unofficial reports had it that the rear engines did not cool sufficiently well, particularly when taking off from the water. Other reports gave the giant boat a somewhat low performance. The change to 12 Curtiss Conqueror water-cooled engines of 600 horsepower would tend to substantiate the truth of both views.

With the water-cooled engines shown in the accompanying photograph of the *DO-X*, the radiator is in front in the slipstream of the front propeller, and both engines have an equal chance of cooling.

Those who remember the photographs of the *DO-X* published previously in this magazine, will note two other important changes. A small auxiliary wing, placed some four feet above the main wing, formerly connected all the engine nacelles. This wing has disappeared, and there is now but a simple streamline brace running from nacelle to nacelle in its place. Our opinion is that the interference between main wing and auxiliary wing was found to be detrimental to efficiency.

Another change is in the support of the nacelles above the main wing. This used to be in the form of a single gigantic streamline strut. Now this support is in the form of struts and braces of more conventional dimensions. Here, again, the large streamline strut probably diminished the lift and efficiency of the main wing. The large streamline support *per se* may have had less resistance than the present exposed nacelle bracing, but the interference between large strut and wing was another matter. The interior of the cabin has been re-decorated and re-furnished for the comfort of passengers on long flights. The interior now looks as comfortable as the salon of an ocean liner.—*A. K.*

THE SECRET OF AVIATION SPEED

CAPTAIN Frank Hawks, who recently crossed the continent in half a day, is an exponent of aviation speed. To an interviewer of *The New York Times*, he said, "I believe this last trip did prove that an aerial pony express on a 13- to 15-hour schedule between New York and the west coast is practical to-day. Why waste time loafing along at 100 miles an hour when planes can be built to fly 200 to 300 miles right now? Five hours to Miami, 15 hours to the Canal Zone, three to four hours to Chicago. That is the speed for our bankers who must send interest-bearing securities, and that is the speed our designers and engine builders must prepare for and prepare for soon."

The National Air Races at Chicago certainly backed-up Captain Hawks' point of view. This year saw the application of still more power, and also increased refinement in streamlining.

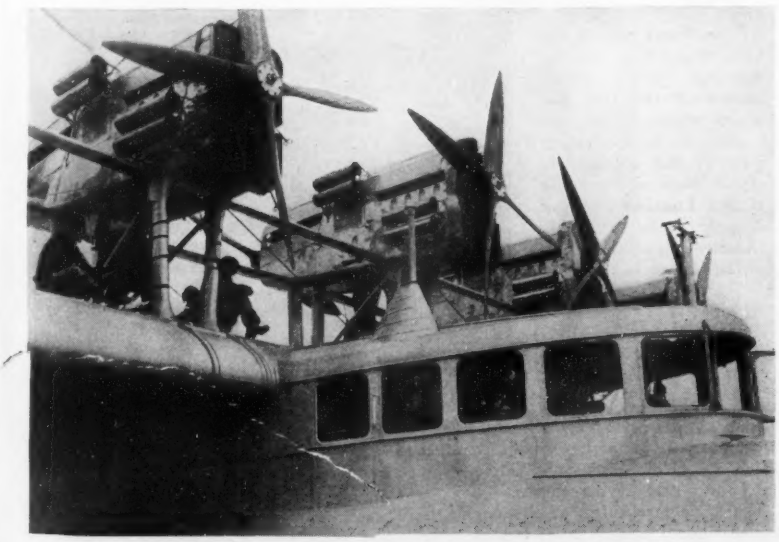
The picture of the re-vamped Curtiss Hawk pursuit plane serves to explain high plane speed. Here is a comparatively small plane, powered with a 600 horsepower Curtiss Conqueror engine. This engine, with tremendous heart, is small of body. It is completely enclosed in the beautifully streamlined body. It is water-cooled, yet we do not see a radiator! That is because the radiator is part and parcel of the wing. The cooling surface is also the covering surface of the wing, with water circulating in a multitude of concealed tubes. Cooling is thus obtained without any expenditure in head resistance. The wheels are streamlined in so-called "pants." There is but one wing, and the strut ends are carefully faired into this wing. The landing gear consists of but two cantilever struts, one on each side. There can be little further refinement in the attempt to gain speed.

Trophy-winning Curtiss Hawk pursuit plane rebuilt for better performance. Most of the features described in the accompanying text are visible in this view

Such aerodynamic efficiency is part of the secret of airplane speed; lightness of structure is another part; and lightness of motor for high power is yet another. But there is one fundamental difference in principle which differentiates the airplane from all other methods of transportation as regards speed.

In all vehicles, be they surface vessels, trains, airships, or automobiles, the air resistance goes up as the square of the speed; the horsepower as the cube of the speed. That is why an ocean liner cannot be pushed beyond 30 knots or so, without the use of absolutely prohibitive power.

But in the airplane, the resistance is independent of the speed. It is dependent only on the aerodynamic fineness of the plane. If the fineness is high—if the ratio of lift to drag is 15—then one pound of weight will require only one pound of pull, no matter what the speed. Therefore speed can go up indefinitely. Some authorities claim 500 miles per hour to be the limit, because after that, air friction will set the plane on fire! But 300 miles an hour as a commercial speed is certainly within the limits of possibility.—*A. K.*



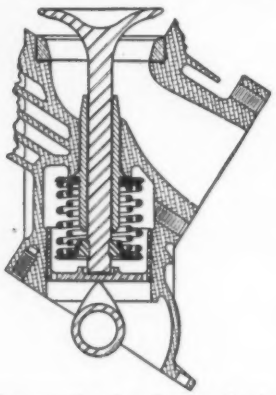
The Dornier *DO-X* in slightly revised form, with water-cooled Curtiss Conqueror engines, now being prepared for its forthcoming flight across the Atlantic

AVIATION FINANCES

AFTER the mad, though happy days of 1929, American aviation is suffering from the same depression that other industries are meeting. The President of Air Investors, Harvey Williams, paints a gloomy picture in his report summarizing 1929 and first-quarter-1930 conditions. The most important holding companies are probably United Aircraft and Transport, Curtiss-Wright, and Aviation Corporation. Aviation Corporation reported a first quarter loss of 863,651 dollars as compared with a loss of 1,441,000 dollars for the last six months of 1929. Curtiss-Wright suffered a loss of 1,620,920 dollars as compared with a loss of 668,000 dollars for the full year of 1929. United Aircraft and Transport re-

ported earnings of 39 cents a share as compared with 89 cents for the first quarter of 1929. Inventories are still heavy, smaller manufacturing companies are disappearing, and production is very low. But there is a brighter side to the picture!

Colonel Clarence M. Young, Assistant Secretary of Commerce for Aeronautics,



Unconventional valve mechanism of the new inverted airplane engine

gives a totally different viewpoint in his report to Mr. Hoover.

About 18 months ago, 35 companies were operating 59 different scheduled airlines over the airways and were flying a total of 69,000 miles every 24 hours.

At the present time there are 45 such companies engaged in the transportation of mail, passengers, and express, flying approximately 120,000 miles per day. These 45 carriers now operate 137 different routes.

Colonel Young foresees great progress when the provisions of the Watres Airmail bill are given full effect.

The first result under this bill will be the extension of the airmail to various parts of the country not now being served, because it will permit the Postmaster General to utilize the facilities of existing passenger lines.

Second; it will assist materially in the establishment of a more comprehensive passenger service throughout the nation by permitting present airmail carriers to go into the passenger transportation business.

While private flying is still lagging behind, this enormous and rapid growth in transportation will eventually give the manufacturers ample scope. More lines will mean more pilots, hence more students, hence more training planes.

No matter how gloomy the financial statistics of earnings, losses, inventories, assets, and so on, may look, the future of aviation is just as sound as ever. The slump is certain to be followed by a rapidly increasing prosperity of the whole industry. —*A. K.*

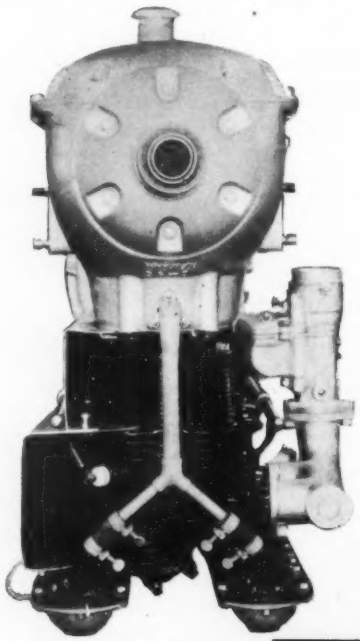
LOUIS CHEVROLET'S AIRCRAFT ENGINE

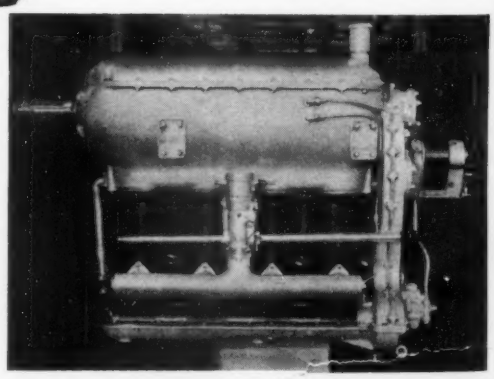
WELL known as the winner of many automobile races and the designer of racing automobiles, Louis Chevrolet has now designed an excellent aircraft engine, the Chevrolet "333." The fashion in low-power motors for aircraft now seems to run to the inverted, cylinders-in-line type, and it is to this category that the 333 belongs. The inverted engine, with the propeller-thrust line at the usual position, gives the pilot the best possible vision forward; the top of the crankcase is well below his eye, and there are no cylinders, exhaust stacks, or other impediments to sight.

The specifications of the 333 are interesting because they indicate that the popular four-in-line air-cooled type of engine is increasing in power and decreasing in weight.

Bore of the 333 is 4.5 inches; stroke is 5.25 inches; and piston displacement is 333 cubic inches (hence the name of the engine). It is rated at 120 horsepower at 2100 revolutions per minute and the weight (dry) is 260 pounds. Fuel and oil consumption is less than half-a-pound per horsepower-hour. (Aircraft engineers never think in gallons of fuel but in pounds, because weight is the important item rather than cost as is the case with the motor car owner.)

The air to cool such an engine must be carefully directed; the front view shows the scoop at the left side of the engine. Be-





Above: **Front view of the Chevrolet 333 engine showing, as a black square at the left, the scoop which directs the cooling air to the hottest part of the engine.** ***At right:*** **Side view of the engine. Looking over the smooth crankcase of this inverted engine, the pilot's vision is not obstructed**

cause of the special type of head, the cooling air passing through the scoop has no interference from the exhaust stacks—which are below—and strikes directly on the hottest part of the engine.

The valve mechanism of the engine is unconventional and deserves special mention because the valves are actuated directly through lifter cups of Nitralloy steel. The cams strike the lifter cups a trifle off center, causing each cup to rotate every time it is struck. The valve springs are both wound in the same direction and each time the valve operates these springs have a tendency to twist the valve, thereby equalizing the seat. The entire valve mechanism is in a constant bath of oil and it is claimed that no adjustments are necessary. This should certainly be a great relief to the aircraft mechanic!

The special exhaust outlet enables the stacks to be placed under the engine, so that cooling air is not impeded and the exhaust pipe can be most conveniently located right under the engine. Carburetion is supplied by a Zenith down-draft carbureter. The down-draft principle is being rapidly accepted in aircraft practice.—*A. K.*

DO AIRLINES PAY THEIR WAY?

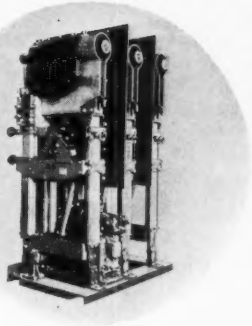
AIRPLANES do not pay their way, according to M. Henri Bouché, Editor of *L'Aéronautique* who presented a formidable statistical monograph to the first International Aviation Conference of the League of Nations.

Each mile flown by commercial transport planes in 1929 cost British taxpayers about six dollars for lines going to distant parts of the Empire, and $1.28 for British-European lines. The French taxpayer suffered to the extent of $1.09 a mile, and the German 70 cents. In the United States we are proud of the fact that there are no subsidies to our airlines. But M. Bouché is of the opinion that, taking into account the high rates charged for airmail—considering weight, much higher than those paid by passengers—there is an indirect subsidy of about 70 cents per mile flown.

"The great size of the United States, its huge volume of urgent business, and other conditions make it the promised land of commercial aviation, yet even there the airlines enjoy only the undeniable promise of future prosperity and meanwhile live with the help of postal subventions and private subventions in the form of the large amounts of capital they were able to find during the last two speculative years."

This may be true, but the United States is reducing its mail contract rates, new capital is not being put into the industry, and traffic is growing rapidly and steadily. In a very few years American air transport will be an entirely self-supporting industry, which is far more than is probable in Europe.

M. Bouché has found, however, two entirely profitable airlines, both outside of



Whoa, there, You Ions...

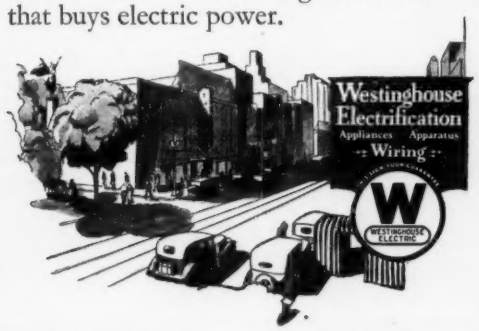
Out of the mercury arc tube — that odd-shaped bubble of glass with horns at the sides and a pool of quicksilver in the bottom — has come new light on one of the electrical industry's oldest problems.

For years research men had sought to control the arc that flashes between contacts every time a high-power electric circuit is broken. Several methods had been applied with practical results; yet the basic principles of arc formation and control remained unknown.

Then, not long ago, an engineer in the Westinghouse Research Laboratories, while working on applications of the mercury arc tube which demanded accurate arc control, concluded that the impetuous energy of any arc was due to the impetuous ions that compose it. "Harness the ions," he told himself, "and you harness the arc."

So successfully is this principle applied in the new De-ion circuit-breaker that heavy voltages can now be interrupted in open air with scarcely a flash. The electrical industry hails it as revolutionary. Important improvements are effected in a vital class of electrical equipment which the public rarely hears about—yet on which depends that smooth 24-hour-a-day flow of current now taken so much for granted.

Through discoveries and developments such as these Westinghouse research helps to give homes, industry, and transportation more value in exchange for the dollar that buys electric power.



Tune in the Westinghouse Salute over WJZ and the coast-to-coast N. B. C. network, every Tuesday evening.

Westinghouse

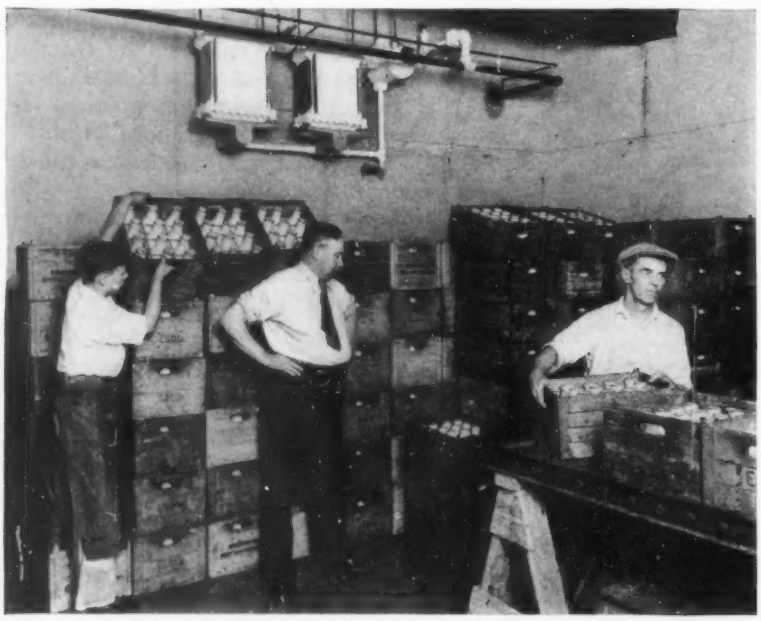
Europe and the United States. One is the German Scadta in Colombia, the other the Junkers Company in Persia. Exceptional geographic conditions enable these companies to charge what the service is really worth, namely three to six times the European air rates.

The statistics for 1929 will be very encouraging to American readers. During that year, the world had 137,000 miles of regular airways on which 2000 planes carried 600,000 passengers and 14,000 tons of freight. The United States carried 165,000, or more than one fourth of this number of passengers, and had a scheduled flying mileage of 21,000,000 while the next in rank, Germany, had only 7,000,000 flying miles during the same period.—*A. K.*

STORAGE PLANT REFRIGERATION UNIT

THE science of food preservation, which has passed through a series of marked refinements during the past few hundred years—from the days of spice application to the present era of automatic electric refrigeration—is still very much the object of the engineer's attentions.

An ingenious piece of apparatus that represents another step in the improvement of refrigerating equipment has just been perfected by the Grinnell Company. This device, known as the Unit Cooler, takes the place of the maze of pipe coils that form a regular part of the refrigeration system in milk plants, storage rooms, meat plant storage rooms, warehouse vegetable quarters, and many other commercial rooms that require conditions conducive to food preservation. The dimensions of this cooler



A refrigerated storage room which has no maze of pipes nor any drip of condensed moisture. The automatic refrigerating unit is shown on the wall at left

are only 18 by 18 by 19 inches, as contrasted to the 600 lineal feet of pipe employed in the old system, and weighs but 300 pounds as contrasted to three tons of pipe coil.

With the Unit Cooler, an automatic defrosting process is carried on throughout the day. The air in the room is therefore always sweet and refreshing. In addition there is a uniformity of temperature in the room that was lacking in the old system, and that is highly desirable in a commercial installation.

The liquid refrigerant that feeds an automatic refrigeration system is controlled in this apparatus by a new device known as the liquid level control. This prevents an overfeeding of refrigerant to the system.

The small size of the Unit Cooler also makes it applicable to domestic usage. The device may be easily transported from one location to another, a feature which makes entirely feasible a system of household refrigeration and humidification comparable to some of the installations now employed so successfully in theaters and retail stores.

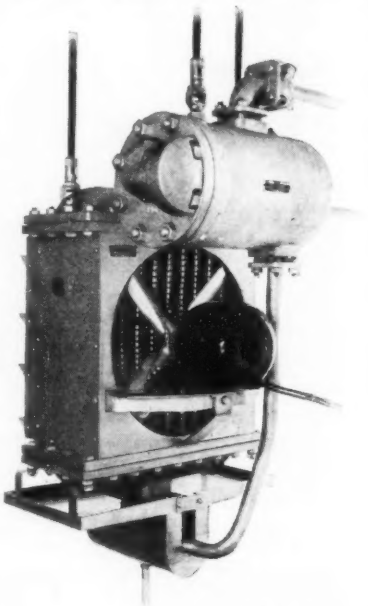
AIRCRAFT PARTS FROM SALT WATER

SALT water is the source of a metal that gives promise of playing a vital part in aircraft construction in the future. The salt brines of Michigan constitute the important raw material for magnesium production in the United States, according to John A. Gann in *Industrial and Engineering Chemistry*.

The natural brine, containing magnesium chloride, is pumped from wells 1200 to 1400 feet deep. By a series of treatments, the other salts in the brine, namely sodium chloride, sodium bromide, and calcium chloride, are removed, and the remaining magnesium chloride is evaporated to a white powder, dried, and finally fused in an electrolytic cell, where the metallic magnesium is made.

The most striking property of this metal is its extreme lightness. With a specific gravity of 1.74, it is only two thirds as heavy as aluminum, one fourth as heavy as iron and, one fifth as heavy as copper. By proper alloying and heat treatment, magnesium alloys are obtained with strength and toughness that permit them to compete successfully with other engineering metals. These properties, coupled with their high specific heat, electrical conductivity, and thermal conductivity, immediately point out many practical fields of application.

Simultaneously with the development of aeronautics has come a demand for metals



Rear view of entire refrigerating unit showing the fan which plays a stream of air on the cooling pipes

with a maximum strength and minimum weight. This call was first answered by the light aluminum alloys, and now more recently by the ultra-light magnesium alloys. The more important possible applications in this field include crankcases, oil pans, seat frames, superchargers, instrument housings, control levers, impellers, and pistons. Results to date on both laboratory and flight tests indicate a big development in the forged propeller business. The properties that fit these magnesium alloys for aircraft use are their extreme lightness, high strength, and good fatigue endurance —that is, their ability to withstand repeated applications of stress.

The advantages derived from the use of light magnesium alloys are by no means limited to aeronautics. Distinct improvement in performance has been obtained when using them in many of the reciprocating parts of machinery.—*A. E. B.*

FINDS NERVES MAY CAUSE EYESTRAIN

EYESTRAIN, so-called, is more apt to be the result of "nerves" than of any disease of the eyes, Dr. George S. Derby of Boston told members of the American Medical Association at their meeting in Detroit recently. Dr. Derby described a number of cases he had seen in which the patient recovered from his eyestrain when his bodily condition was treated and when the psychologic cause of his eyestrain was explained and he was persuaded to use his eyes normally.

"If the general p.blic could learn that

eyes are seldom strained, this would be a much happier world to live in," he said. "The fact of the matter is that the eye is provided with a large factor of safety and that healthy eyes do not become diseased even by excessive use."

Most of these cases of ocular neurosis, as Dr. Derby called it, are found in sensitive nervous persons. Fear is the commonest factor in these cases. Some ocular pain or discomfort makes the patient afraid that he is injuring his eyes permanently, that he cannot continue his occupation and perhaps will become dependent. Many of Dr. Derby's patients had given up their work and many pleasures, and were devoting themselves to resting their eyes as much as possible.

Dr. Derby asked opthalmologists not to overlook the psychologic factor in causes of eyestrain, and to treat the mental condition of their patients as well as to correct their vision with eyeglasses.—*Science Service.*

DIAMOND MATCH 9 FOR 1 SPLIT-UP

A PLAN for recapitalization of the Diamond Match Company provides for the formation of a new company with a capitalization of 1,000,000 shares of 6 percent cumulative participating preferred stock of 25-dollar par value and of 1,500,000 shares of no-par common stock, this stock to be distributed to present shareholders at the rate of five shares of preferred stock and four shares of common stock for each share held. In addition, if the plan is approved, a dividend of 25 dollars in cash will probably be declared prior to the transfer of the properties, good will, and business of the Diamond Match Company to the new corporation.

Stockholders were asked to deposit their stock with the Bank of America (N.A.) or Continental Illinois Bank and Trust Company on or before October 15.—*Barron's.*

10,000-DOLLAR RADIO IDEA CONTEST

WITH the opening, on September 25, of the Westinghouse Radio 10,000-Dollar Idea Contest, the Westinghouse Electric and Manufacturing Company extended to all America an invitation to join its cabinet designing staff. At that time, the company opened a nation-wide suggestion box with an offer of prizes totalling 10,625 dollars as an incentive for offering ideas for cabinets.

Anyone may compete except employees of the Westinghouse Electric and Manufacturing Company. The contest closes December 24, 1930, and all ideas must be in the mails before midnight December 24. The winners will be announced January 19, 1931.

The rewards for which those who accept the invitation and join the Westinghouse Radio "Idea Department" will compete, range from the first prize, a trip to Europe with all expenses paid or 5000 dollars in cash, to 25 prizes of 25 dollars each; and include between these limits the second prize, a 2000 dollar automobile of the winner's choice or 2000 dollars in cash; the third prize, a 1000-dollar check; five prizes of 200 dollars each; five prizes of 100 dollars each; and 10 prizes of 50 dollars each.

How to provide a RETIREMENT INCOME for yourself

THIS new Retirement Income Plan makes it possible for you to retire at any age you wish, 55, 60, or 65. You may provide for yourself a monthly income of $100, $200, $300, or more.

Suppose you decide to retire on an income of $200 a month when you are 60. Here is what you get:

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Say good-by to money worries forever

2. Upon your death from any natural cause before age 60, your wife or any other heir you name receives a cash payment of $20,000. Or if preferred, your wife receives a monthly income for life.

3. Upon your death from accidental means before age 60, your wife or other heir receives a cash payment of $40,000. Or if preferred, your wife receives a monthly income for life.

4. If serious illness or accident stops your earning power for a certain period, you will thereafter receive an income of $200 a month during such disability, even if it lasts the rest of your life.

How much does it cost?

A Retirement Income is paid for in small installments of only a few dollars a month. The exact amount depends on (1) Your present age (2) The age at which you wish to retire (3) The amount of monthly income you will want.

One of the great advantages of this Plan is that it goes into operation the minute you pay your first small installment. Even though you should become totally disabled, you would not need to worry. Your installments would be paid by us out of a special reserve fund.

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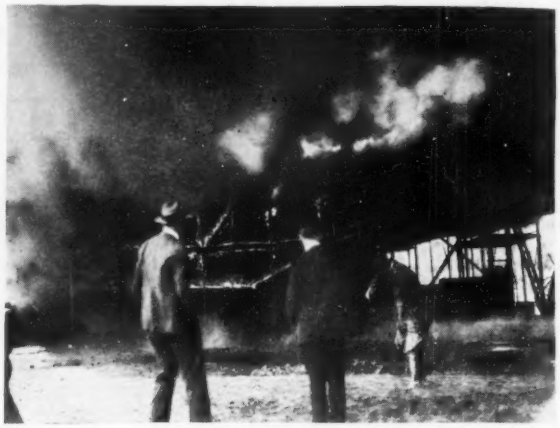
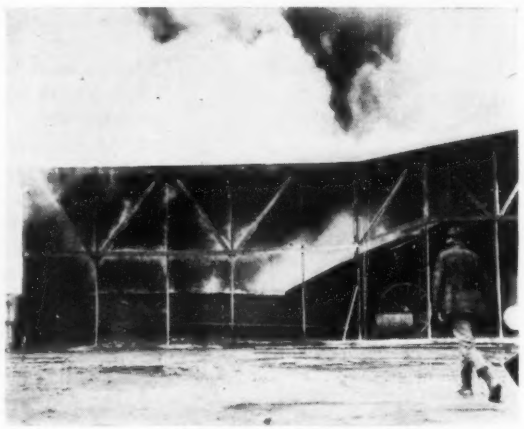




Above, left: **Fire in a lacquer dip tank and drain board, such as is used for finishing automobile parts**

Above, right: **Foamite is being released automatically, and is starting to smother the roaring flames**

Right: **The dangerous fire entirely subdued. This photograph was taken 28 seconds after the one at the left above**

These prizes will be awarded to those submitting the best 48 original and acceptable ideas for beautifying radio cabinets. If a winning idea is submitted by more than one person, the full prize will be awarded each contestant. All prize winning ideas will become the property of the Westinghouse Electric and Manufacturing Company.

It will not be necessary to submit drawings of the ideas one enters in this contest—a written description is all that will be required; however, sketches may be submitted if desired, in which case they should be accompanied with explanatory text. A person may submit as many ideas as he wishes; each suggestion should be on a separate sheet with the originator's name and address.

The judges for the Westinghouse Radio Contest will be: Miss Helen Koues, Director of Good Housekeeping Studio; Miss Neysa McMein, famous artist; Miss Rosamond Pinchot, prominent actress; Raymond Loewy, famed Parisian artist and designer; E. B. Ingraham, Vice-President, Times Appliance Company, Inc., New York City; and A. W. Robertson, Chairman of the Board, Westinghouse Electric and Manufacturing Company.

Contest entry blanks and leaflets giving helpful suggestions for conceiving acceptable ideas are available at any Westinghouse radio dealer's store.

Ideas should be mailed to Westinghouse Electric and Manufacturing Company, Radio Department, 150 Broadway, New York City.

TOILET WATER DERMATITIS

THE intricacies of modern civilization have brought new diseases and unusual hazards into modern life. However, the use of cosmetics seems to go back to the beginning of woman's vanity, and certainly that was the beginning of woman herself! Among the most frequently used cosmetics are toilet waters. Recently specialists in diseases of the skin have been seeing occasionally cases of unusual pigmentation or brown streaks running down the back of the neck. The cause of these unusual disfigurations was not understood until a specialist discovered the relationship between pigmentation and the use of eau de cologne.

Freund applied eau de cologne to the forearm of a boy and exposed this surface to the sun and to sea water. The boy developed inflammation of the skin with pigmentation. The investigator then asserted that the offending ingredient was chiefly oil of bergamot. He then rubbed oil of bergamot on the forearm of the boy and obtained the same result. Since that time numerous cases are being reported by physicians to whose attention they have come.

There are, of course, other instances in which the ingredients of perfumes and toilet waters produce irritations and pigmentation without exposure to sunlight. In these instances there is a special sensitivity which manifests itself immediately after the perfume is used. The oil of bergamot is, however, the substance primarily responsible for the special form of irritation with pigmentation that is now called "toilet water dermatitis."—*M. F.*

CHEMICAL TRICKS WITH SUGAR LUMPS AND LACQUER

WE were eating luncheon together the other day, a fire-prevention engineer and a mere chemist, the latter hoping to pick up some novel kink in the spectacular science of fire-fighting to pass on to SCIENTIFIC AMERICAN readers through these columns.

"Speaking of fires," said the specialist, "did you ever try to burn sugar?" And taking a lump from the sugar bowl he applied a match. The sugar melted but did not burn. At his invitation, we tried to ignite another lump with the same results.

"Now," announced our friend, impressively, "I will make a few magic passes over this same lump of sugar and behold it burns, readily, and even fiercely."

"Marvelous!" we applauded. "How did you do it?"

Pressed for the explanation, the student of conflagrations explained that he had surreptitiously touched the corner of the sugar lump to some cigarette ashes after which it immediately caught fire. Having satisfied ourselves that a tiny smudge of cigarette ash "did the trick" every time, we began speculating as to the chemical cause of its action. After some high-spun theories had been hazarded, the expert explained that any salt of potassium seems to work the same way and that the ashes induced the flame simply by virtue of the potash they contain. This seemed sufficient explanation to our informant, so we refrained from the question which we longed to ask—why does potash induce burning? We were pretty sure he didn't know why because the only explanation we've ever heard is that the potassium acts as a catalyst, promoting oxidation and combustion. And we didn't want to embarrass our friend, lest he might neglect to give us the "story" we wanted. As proof that our tact was fruitful, we reproduce herewith three exclusive views of a recent spectacular test of a modern Foamite fire extinguisher.

The conflagration was started in a large dip tank and drain-board, such as is used in automobile factories for dipping such parts as mud guards into the highly inflammable enamel. One photograph shows the blaze gaining headway and threatening the complete destruction of the "factory." In the second one, the automatic foam engine has begun to apply a blanket of thick

"suds." The last one shows the blaze completely subdued, just 28 seconds after the Foamite application began.

All of which would indicate that the fire prevention engineer is adept in the magic of chemistry applied either to sugar lumps or blazing enamel.—*A. E. B.*

GREATEST AERIAL BEACON RIVALS SUN

THE Lindbergh beacon, the most powerful aerial light ever erected by man, has been installed on a tower on the Palmolive Building, 602 feet above the city streets, to guide fliers to Chicago.

Equivalent to a half inch section of the sun and hypothetically equal to the brilliance of two billion half-inch candles set side by side, the lamp has a visible light beam of 500 miles, lighting engineers declare. They point out that while two billion candles would occupy the area of a city block, this amount of light is concentrated in a 60-inch carbon lamp weighing a little more than a ton.

While the light's beam is visible 500 miles away, at this distance, because of the curvature of the earth, it is at an altitude too great for airplanes to reach. For practical purposes, the authorities estimate the greatest visible distance to be 300 miles from Chicago.

This beacon, dedicated to Colonel Charles A. Lindbergh by its donor and designer, the late Colonel Elmer Sperry, inventor of the gyroscope, is defined as a monumental product of modern electric light engineering science.

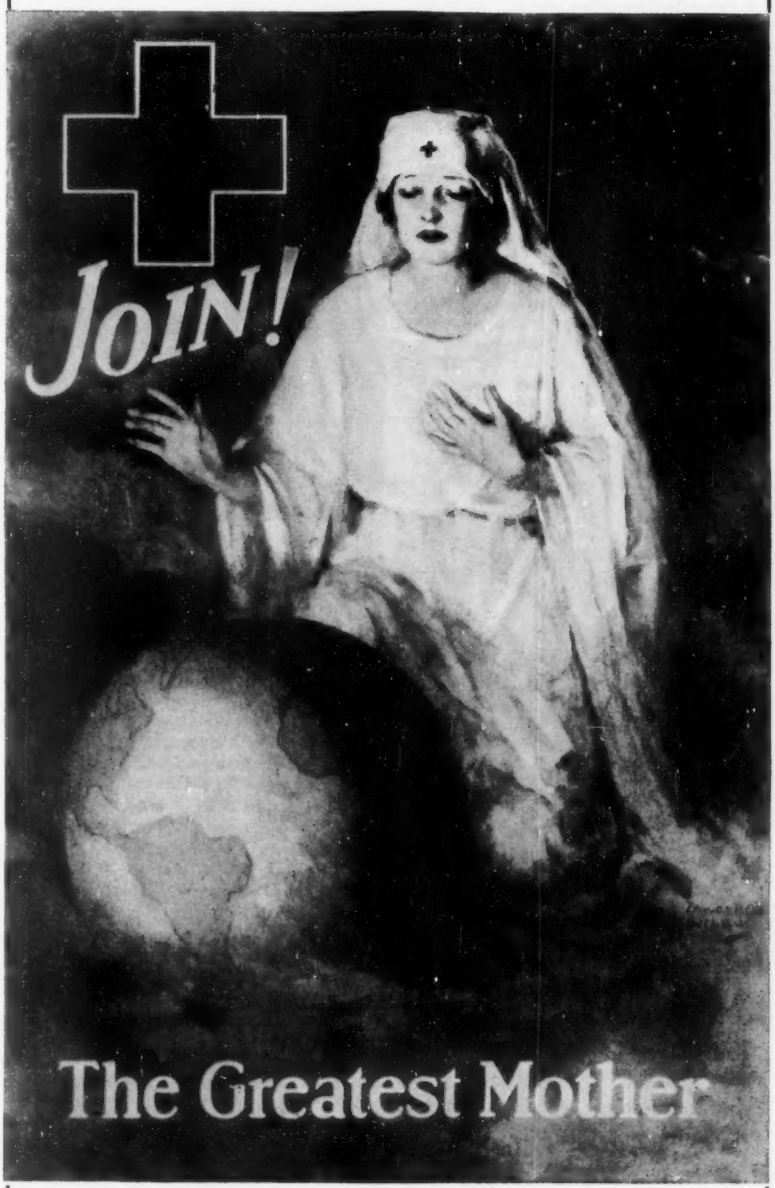
ASBESTOS INFLAMMATION OF THE LUNGS

WHILE the asbestos industry is more than 2000 years old, it has only within the past few years taken a prominent place among the great industries. With the development of the industry, physicians have begun to notice cases of extensive fibrous changes in the lungs due to the inhaling of the asbestos particles and inflammation of the lungs set up by the particles. When the material is taken into the lungs, it can be found in the tissues in the form of black particles. Similar particles are to be found in the sputum of the patient and indicate to the physician the source of the disorder. Drs. K. M. Lynch and W. A. Smith have described several cases in which these asbestosis bodies were seen in the sputum when the sputum was studied under the microscope. By the use of proper stain methods, they are given prominence. Thus there is provided for the scientific physician who is confronted with such a case a certain method of diagnosis.—*M. F.*

ELECTRICAL CONDUCTIVITY AT LOW TEMPERATURES

THE property of super-conductivity—that is, the disappearance of electrical resistance at very low temperatures—which has been discerned for lead, mercury, tin, iridium, and thallium, has been found by German investigators to apply to the carbides and nitrides of heavy metals. Thus the critical temperatures under which the resistance disappears is 9.3 degrees absolute for tantalum carbide. It appears possible

(*Please turn to page* 402)



THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

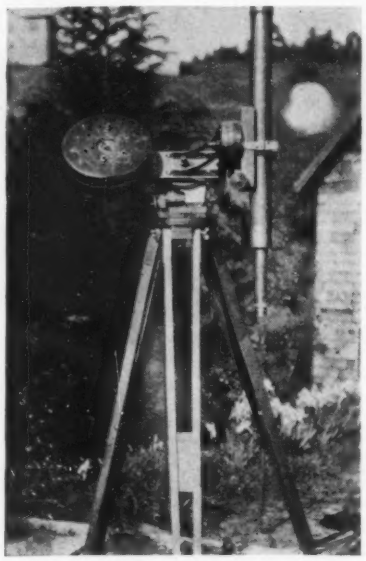
NOW that cold weather is peeking round the corner, amateurs soon will be ready to hibernate in cellar workshops, taking with them two disks of plate glass, some abrasive, and some pitch, to see what kind of a telescope can be knocked out of these "makings." This month, then, we reproduce, by way of inspiration, a number of descriptions of jobs already done by amateurs who found that the practical working instructions in the SCIENTIFIC AMERICAN book "Amateur Telescope Making" actually did instruct.

A. E. PARKE, 6453 Oliphant Avenue, Chicago, sends in a snapshot and says. "This is our first telescope which our boys and myself have just finished, a six-inch reflector which has turned out very satisfactorily. The craters on the moon and the

A. E. Parke and his telescope

moons of Jupiter are very distinct with a half-inch eyepiece. We have not yet had a chance at the other planets. The figuring of the mirror developed with very little trouble, and we have a total absence of color or distortion. Our mounting is made of pipe fittings on a wooden tripod and works very well. We have learned much in making this one and hope to have a still larger one."

FRANKLIN B. WRIGHT, 155 Bret Harte Place, Berkeley, California, says: "While gazing at the Milky Way in the high Sierras I resolved to have a good portable instrument next time. The result is shown in the enclosed snapshot. It consists of a 60 millimeter (2⅜ inch) Bausch and



Franklin B. Wright's refractor

Lomb objective costing 30 dollars, about nine dollars' worth of brass tubing and about six dollars' worth of wood, bolts and springs and other odds and ends for the mountings and tripod. Since I have no machine tools the mounting is designed to be made with nothing but ordinary tools which everybody has around the home. The bulky-looking counterweight consists of two old Chevrolet brake drums bolted together. It is adjustable in a wooden slot underneath."

E. LLOYD McCARTHY, 10 Powers Street, Canton, New York, a college student, sends in a photograph which shows that times have not changed since days we fondly recall; for the picture gives evidence that Sophomore McCarthy demolished a bridge in order to get a suitable pedestal for his telescope. Here is what he writes:

"The telescope has a six-inch mirror of 46-inch focal length; a one-inch prism; and a half-inch eyepiece. The mirror was polished on a lap of honeycomb foundation after failure with tempered rosin.

"That cast-iron base once did duty holding up a bridge railing. The bearings and axes are pipe fittings; the counterweight was made by casting a calculated amount of lead on a length of pipe. Two semicircular pieces of eight-inch strap iron grip the tube at its center of gravity.

"I have had some good 'shots' at four of Jupiter's moons as well as its belts; our own moon; and terrestrial objects. The other day I lectured about my telescope to one of the physics classes at St. Lawrence University, where I am a sophomore. Judging from the questions and comments afterward, about half of the class want to build telescopes of their own."

TURN now to page 71 of "Amateur Telescope Making" (the second, or 1928, edition) and you will see a telescope made by H. O. Bergstrom. Since then this enthusiast, who is a locomotive engineer at North Platte, Nebraska (P. O. Box 491), has turned out another—two more in fact, but one of the pictures he sends is out of focus so we can't reproduce it.

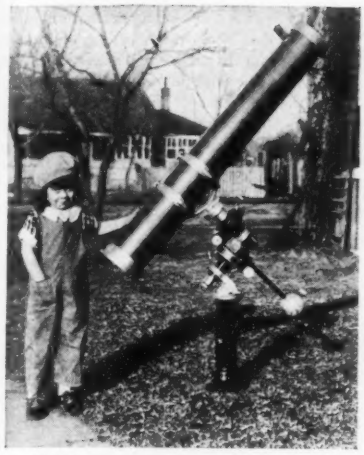
"Though it's a long time since you have heard from this 'T. N.' my enthusiasm in the work hasn't waned a bit," this Casey Jones (we'd like to ride behind him) writes. "I'm enclosing two photos. One of them is another six-inch reflector; the other is the eight-inch glass shown in the July 1928 number of SCIENTIFIC AMERICAN, with the mounting reconstructed. The equatorials for both these telescopes have a special 'North Platte type' quick-setting slow motion control, a real luxury for the amateur. The mount for the six-inch glass is made from an old cistern-pump stand and two Ford front wheel hubs. The other mount is made up of 'pump-stand' 1½ inch pipe fittings and two Ford transmission drums. The little 'star' standing by the six-inch glass is Marjorie Castell, aged four.

"I'm still at work on an eight-inch Cassegrain but on account of having very little leisure time the progress is slow.

"I have received quite a number of requests for a description of my earlier telescope, since it was published in the SCIENTIFIC AMERICAN. A few requests are still straggling in. Requests were received, among others, from Canada, Cuba, Australia and Java."

WRITES Paul W. Spain, 226 Seventh Avenue, North, Nashville, Tennessee: "Well, I finally got it finished. It is rather

McCarthy's "bridge type" mount



Engineman Bergstrom's telescope

crudely done, but I think it will do for a starter. The Foucault shadows were very well defined, however. I used a frosted 40-watt light in testing, and found that it gives a much better light. I was successful in my silvering the first time, probably due to beginner's luck. The tube is an old stove pipe found in a nearby junk pile.

"I am now planning a ten-inch reflector, with setting circles. The labor is certainly well repaid that is put into a telescope."

THE descriptions given above pertain to typical telescopes made by the average amateur bitten by the bug. We have on hand for publication a number of others, and these bread-and-butter jobs will be sprinkled in, as it were, with a variety of more out-of-the-ordinary things. For example there is a water-clock drive (and it actually works, too) by the old-timer Harold Lower; a telescope made in Australia; a 16-inch reflector mounted on giant sized pipe fittings; the new "milk pail" mounting discovered in Detroit; a circus telescope (Chrysanthemum our cynical office cat says they all are, but she doesn't know); a 12-inch Cassegrainian by Porter which is so smooth looking you'd want to take it to bed with you; also a 21-inch Cassegrainian by England's leading amateur, J. H. Hindle.

Paul W. Spain's Number One

Jolt your MIND out of its RUT

with this history of Man's struggle to solve the riddles of the Universe

DO you smile at the people who thought the earth was flat? Are you contemptuous when you read how—when Galileo proved that light bodies fall as fast as heavy ones—people shrugged and called his experiments foolish?

You yourself may be just as smug about *your* knowledge of the universe. You, too, may shrug, and call impractical the calculations whereby Einstein has shattered every hallowed law of time and space.

Too many of us have let a blind spot creep into our mental outlook. We have no rounded picture of the world we live in, because we do not know what science has done and *is doing* to form our beliefs and ideas about it. And in supplying that information, this book of Langdon-Davies comes as a Jolt—an incomparable mental stimulus.

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The crowded, fascinating pages of *"Man and His Universe"* tell the story. They show how the facts you casually accept—the shape of the earth, movement of the planets, gravitation, evolution, atoms—came into being, and how they fell on the men and women of their days as shattering conceptions. In them, too, you will read how your own culture can be immeasureably broadened by the living, breathing procession of science's oldest and newest discoveries.

H. G. Wells, James Harvey Robinson, Richard Swann Lull—The New York Times and Tribune, the Philadelphia Ledger, etc., etc., have praised this book. Harry Elmer Barnes says, "It may work a greater revolution in human thinking than Darwinian evolutionary doctrines and their popularization. If there ever was a book which intellectual liberals should conspire to give the widest possible circulation, it is this one."

"Man and His Universe" is a book to read and to own. The coupon below makes it easy for you to get your copy—for FREE examination—at once. **$5.00**

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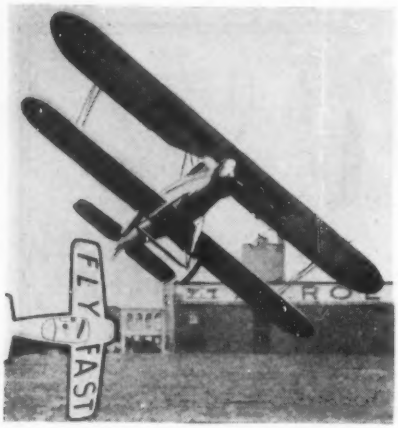

ONE OF 200 ILLUSTRATIONS

A Chandelle: The diagram represents a highly valuable way of showing how controls look when plane reaches position indicated. Black bar is the rudder. Black spot with line is the stick. Throttle is at top.

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THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 399)

that compounds exist in which the critical temperatures are still higher. At present this matter is entirely of scientific interest, since it does not seem to fall within the horizon of practical utilization as yet.—*A. E. B.*

FINGER NAILS IN TUBERCULOSIS

SHERLOCK HOLMES and other observant detectives remarked frequently on their ability to judge the character of the individual by his finger nails. A white line across all the nails is usually an indication that the person has been quite sick for some time.

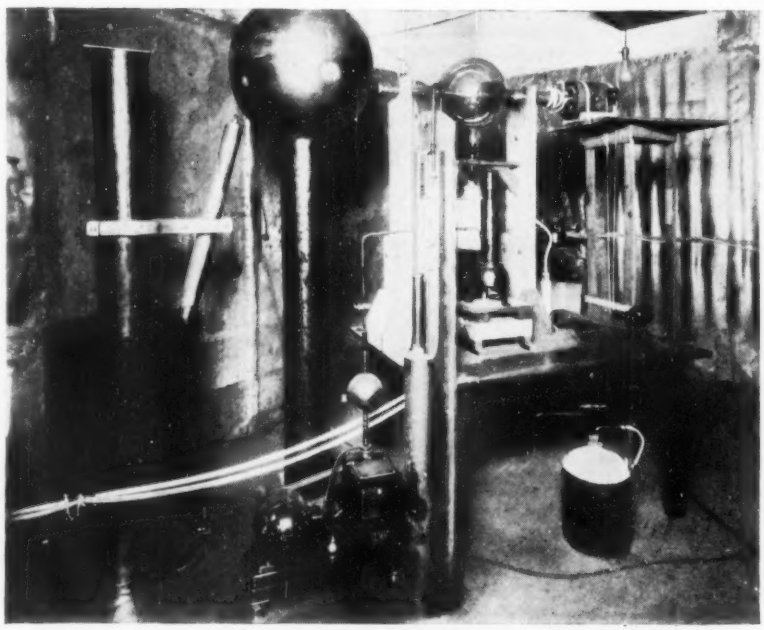
Dr. A. G. Hahn of the Trudeau Sanatorium made a special investigation of patients in that institution, and found that every one of fifty patients with active tuberculosis had pitting of the finger nails. This condition occurred in only three out of fifty patients with inactive tuberculosis, and was not found in any person who was normal. The pitting or depression appeared in the visible part of the nail about six weeks after the onset of the severe symptoms of the disease. The pits were found more often in the nails of the index and ring fingers and do not appear uniformly on the toe nails. Once the pits have appeared they naturally grow forward with the finger nail and are removed during manicuring.

More than 300 years before the Christian era, the school of Hippocrates mentioned the fact that downward curving of the nails was present in tuberculosis. Doctor Hahn found that normal people did not show such curving, 30 percent of the ex-patients had the condition, and 76 percent of the patients with active tuberculosis had downward curving nails.—*M. F.*

MAKES WELDS AIR-TIGHT BY ELECTROPLATING

AN interesting application of electrochemistry to a problem in steel welding is recounted by J. B. Calva in a recent issue of *Chemical and Metallurgical Engineering.* In building a tubular evaporator, the tubes were welded to the headers by the electric process, but on testing it was found that while the joints were mechanically strong, they were not air-tight, because of the presence of many minute capillary tubes produced by the electric arc.

Since this particular evaporator was intended to operate under a vacuum, it was necessary to make these welds air-tight. Caulking the joints proved vain. The next experiment was to induce the clogging of the capillaries with rust by promoting oxidation in their walls with a solution of ammonium chloride. This treatment also failed. Finally, a permanent remedy was applied. Around each of the welds, and concentric with the tubes, rings made of round structural iron, ¼ of an inch in diameter, were placed. These rings were held in place and insulated by means of small pieces of rubber which were compressed between the iron rings and the projecting ends of the tubes. The rings were then interconnected by means of copper wire and a water-tight wooden cover was



Recent experiments by Prof. J. S. Long of Lehigh University may procure for linseed-oil paint the same quick-drying properties as modern lacquers. The work has been conducted with the huge cathode-ray machine illustrated above. The rays from this tube were focused on samples of linseed oil for various periods and it was found that paint made from oil that had been "bombarded by electrons" for 10 minutes dried in half the time required for ordinary paint. The photograph shows the cathode-ray machine adapted for further experiments on the so-called drying oils. It is placed in a special room, the walls of which are completely covered with sheet lead to prevent the escape of the cathode rays

bolted to the flange. A piece of copper wire connected to the rings was made to pass through a rubber stopper which fitted a hole in the wooden cover.

An electrolyte made up of ferrous chloride, calcium chloride, and water was then poured into the tubes and in such an amount as entirely to keep immersed in it all the iron rings and welds. The electrolyte was kept as hot as possible by means of a steam coil.

The electric welding machine was then adapted for electroplating work by inserting in the magnetic field of the generator a slide-wire resistance. This was done in order to reduce the voltage at the terminals of the generator so as to limit the current to a density of 15 to 20 amperes per square decimeter, calculated on the effective surface of the iron rings.

The positive terminal of the generator was then connected to the copper wire coming from the iron rings and the negative terminal to the evaporator. After 24 hours of electro-deposition of iron on the welds, the evaporator was tested and the maximum expected vacuum was obtained. —*A. E. B.*

USE FLUE GAS TO PREVENT DUST EXPLOSION HAZARD

SO many forms of dust are highly explosive that methods of preventing this hazard have long engaged the attention of chemists in the United States Bureau of Agriculture. One of the expedients they have developed is the use of an inert gas as the atmosphere to surround grinding operations and others that are apt to produce dangerous dust.

Such installations have been made at two hard-rubber grinding plants, a cork grinding mill, and a pyrethrum-flower grinding plant. A number of sulfur-grinding mills have adopted this method of preventing explosions, and a feed-grinding plant in the middle west is now installing one of the largest inert-gas systems in the country. The use of inert gas to provide protection in one of the large starch plants is being considered, and experiments are under way to develop methods of properly cleaning and conditioning the gas for such use. Fire extinguishers filled with inert gas under pressure, instead of chemicals, are now being produced and are finding a ready market in this country.

Methods of cleaning and conditioning flue gas to render it satisfactory for use as a preventive of dust explosion and fires are now being developed.—*A. E. B.*

SPRAY PAPER MULCHES TO AID CROPS

THE use of mulch paper for covering the fields between furrows in order to help the soil retain moisture and to prevent the growth of weeds has been described previously in these columns. An interesting variation of this new idea is being tried out in Germany. Instead of covering certain crops with paper sheets, as is customary in America, a paper coating is sprayed on the fields.

The action of paper coverings results in many cases in a greatly increased production of certain crops, because the soil temperature is increased, weeds suffocated, pests destroyed, and the soil bacteria activated. The paper spray is said to be cheap, cannot be removed by the wind, and is not dissolved by rain. Its most obvious advantage over the use of paper in sheet form is its ease of application. What the effect on the growing plant will be has not yet been determined.—*A. E. B.*

PNEUMONIA FROM INHALING GASOLINE

EXPERIMENTING, boylike, with a rubber tube and the gasoline tank of an automobile, an eight-year-old lad got an unexpected dry cleaning of his lungs, which resulted in pneumonia, when his companion blew on the other end of the tube. The case was recently reported to the American Medical Association.

When the other end of the tube was blown into, the gasoline was forced into the boy's mouth. He choked and had a severe strangling spell, from which he recovered, but pneumonia developed. For four weeks he could taste gasoline and it could be smelled on his breath.

Gasoline is rapidly absorbed by the lung tissue, the report stated. The pneumonia that follows this absorption is not typical. The fever is not high and the rapid breathing continues for a long period. The inflammation of the lungs does not remain in one spot, but wanders about, suggesting that the gasoline fumes also wander about in the lung tissue, setting up inflammation in other spots.—*Science Service.*

TIMING A FLASH OF FLAME

THE factors that contribute to the propagation of explosions in gaseous mixtures are being studied by the United States Bureau of Mines. This is part of the Bureau's investigation of the mechanism of mine explosions. No matter how long the column of an explosive gas mixture may be, the speed of the flame, when initiated, is accelerated rapidly until it reaches a maximum and constant velocity. The term "detonation" is applied to this type of explosion. So fast does the flame front travel that it sometimes reaches the high value of 10 times the velocity of sound, or over two miles a second.—*A. E. B.*

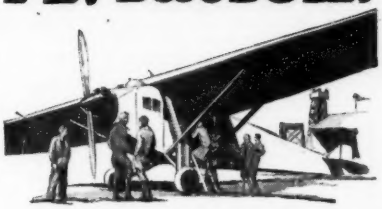
NEW PRODUCT PRESERVES AND IMPROVES GLUE

WHEN the organic chemist begins to juggle atoms, tacking one here and another there on some molecule with a mouth-filling name, no one, including himself, knows what kind of a substance is going to result or what use it may prove to have. Thus, during the past year, chemists of the Dow Chemical Company, Midland, Michigan, have developed, from the laboratory stage to actual commercial production, a new product known as orthophenylphenol. Now what is this substance good for?

Well, being a relative of carbolic acid, one might suspect that the newcomer would be useful as a germicide, but we'll give you 999 guesses as to where it has found application. Answer: In making glue!

The problem of glue preservation, both from the standpoint of preventing mold and that of eliminating putrefaction, has been of extreme importance to both glue manufacturers and glue users. The sodium

"how can I get into Aviation?



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IF YOU read "The story of Anesthesia" by Dr. John H. Evans in the November issue of HYGEIA, the Health Magazine, you may pause at the tale about the above bill and say, "Them was the good old days". But that first rude experiment is a far cry from the perfected science of anesthesia as surgeons administer it today. At some time in your own life, either because of an operation on yourself, a member of your family or a friend, you will be personally interested in some kind of anesthesia. Read Dr. Evans' story of ether and laughing gas in the "good old days". Let him tell you about the wonderful development of perfected anesthetics in "these still better days". Let him put you right regarding the various kinds of anesthesia.

"PHYSICAL ILLITERACY" what is it?

Do you get your exercise listening to the base-ball reports over the radio or sitting in the bleachers watching a football game? This form of exercise is so common to all Americans that it has been given a name—"Physical Illiteracy". Dr. J. E. Rogers points out the grave danger of physical illiteracy upon your individual health, the health of your family, community and country. Read this article in the November HYGEIA.

OTHER VITAL HEALTH ARTICLES in the November HYGEIA

"Perception" by Dr. William J. Mayo; ***"April Blue"***, a child's health story; ***"How to Protect Your Children from Tuberculosis"***—these are only a few of the additional health attractions treated in the November HYGEIA. The articles in HYGEIA are written by health authorities in a charming, non-technical style, pleasing to the layman, who can be sure that the variety of health topics presented are scientifically true. HYGEIA is for every member of the family. Take advantage of this special introductory offer to get acquainted with HYGEIA. The regular subscription price is $3.00 a year, but new subscribers are offered the special get-acquainted-price of $1.00 for six months.

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salt of this phenol is water-soluble in all proportions and, regardless of its high phenol coefficient, is reported by bacteriological laboratories as being non-toxic to humans. The quantities necessary to use are exceptionally small; 0.5 percent of sodium orthophenylphenate by dry weight has proved in all tests a complete control against both mold and putrefaction.

The measured strengths of glue have shown that in quantities from 0.1 percent to as high as 5 percent, sodium orthophenylphenate has in all cases increased the strength of the glue and at the same time has given it a slightly bleached effect which is considered very desirable.—*A. E. B.*

"GALAGUM"

GALAGUM is the name given to a mixture of modified polysaccharides recently introduced and described in *Industrial and Engineering Chemistry*. It is a white powder, tasteless and odorless, and acid in reaction. It can also be obtained in a neutral modification. Galagum, when boiled in water, forms colloidal solutions of different viscosities, depending on concentration. A 1 percent solution forms a syrupy solution, a 5 percent solution forms a paste or jelly.

Neutral Galagum is edible and is used in making bakers' and flavoring emulsions. In the cosmetic industry viscous aqueous solutions are much used in lotions and hair preparations. These are produced by dissolving 1 to 4 parts of Galagum in 100 parts of boiling water.

In the baking industries it has been found that neutral Galagum replaces part of the eggs ordinarily used. In the manufacture of ice cream, neutral Galagum decreases the amount of gelatin required. Certain cheeses which are made with various protective colloids to give them smoothness and body may likewise be made with neutral Galagum.

Technically, Galagum possesses interesting properties in that it may be used for giving a heavier body to water paints, sizes, glue, and many other aqueous solutions. —*A. E. B.*

RESPONSIBILITY FOR TYPHOID FEVER

TYPHOID fever is carried principally by contaminated food and water and by carriers of the disease whose excretions get into food and water. From time to time brief epidemics have occurred in this country due to the fact that sewage has gotten into the water supply. An epidemic occurred in Salem, Ohio, several years ago, when there were several hundreds of cases. Small epidemics have also occurred in factories where the drinking water became contaminated by sewage.

In Lyons, France, recently the court held the water company responsible for the illness and death of various citizens who had become infected with typhoid fever from contaminated water. Moreover, the court declared Mr. Mercier, director of the water works, to be guilty of involuntary homicide as a result of his imprudence, negligence, and infraction of the regulations. They sentenced him to one year in prison, with suspension of execution, and they fined him 500 francs. Some of the people who developed typhoid fever were awarded damages ranging from 20,000 to 100,000 francs.

The epidemic originated from two wells which were contaminated by the water of a sewer. In its decision, the court maintained that it is the duty of the water distributing company to guard the purity of the water that it distributes. The monthly analyses made by the company were inadequate, and the company should not have ignored the dangers associated with the proximity of a sewer to the water supply.—*M. F.*

VARIATIONS IN SUSCEPTIBILITY TO DISEASE

IT has long been known that different races vary in their susceptibility to various disease. Centuries of infection with syphilis have made the Chinese relatively insusceptible to that disorder. Jewish people suffer less than other groups from alcoholism and tuberculosis, whereas they suffer particularly with diabetes and with a disease of the arteries known as thromboangiitis obliterans. The races of Africa and the South Sea Islands have been free for many years from such conditions as measles, but come down with serious epidemics from the disease when it is introduced among them. For some unexplained reason scarlet fever is rare in the tropics; although cases have repeatedly gone into India, South America, and the Philippines, the result is only a local epidemic largely confined to newly arrived foreigners and with few cases developing among the local population. Several investigators have attempted to find out the reason for this immunity, and the most recent evidence indicates that this is due to some hereditary factor.

For instance, the Chinese are relatively free from scarlet fever as compared with the Japanese. Of 11,000 healthy Japanese tested, 37.3 percent were found positive to the Dick test, which was about the same percentage as reported by Zingher for New York City. On the other hand, only 19.4 of 3500 Chinese were found to be Dick positive. For a period of six years, the annual scarlet fever mortality among the Japanese was 361 per 100,000, as contrasted with 8 per 100,000 for the Chinese. —*M. F.*

HYBRID PLANT YIELDS PAPER AND OIL

BROTEX, a newly developed plant which threatens to replace hemp and to supply a suitable raw material for the manufacture of paper, is attracting considerable attention among British chemists. The new plant is being grown in America, France, Germany, Kenya, and Canada, as well as in the British Isles, and its possibilities on a wide range of soils are interesting great numbers of scientists and agriculturists.

Experimental work which has been already carried out indicates that it is a sufficiently hardy plant to be grown successfully to yield a six months' fiber crop in many parts of England and in other countries. In its six months and later stages the plant produces fiber which can be used for sacking, cordage, ropes, and the products in which coarse hemp is usually employed. For paper-making it affords a very quick-growing material. Its seed can

The new home of the Mellon Institute as it will appear when finished

be used for cattle food in the form of oil cake having 15 percent edible oil.

The plant, which is a hybrid biennial, was produced after many years of experiment by Mr. Leonard Browning. No extravagant claims have been made for it, and the closest scientific research is still being carried on.—*A. E. B.*

NEW HOME TO BE BUILT FOR MELLON INSTITUTE

ONE of the most interesting places in the world to anyone interested in chemistry is the Mellon Institute in Pittsburgh, Pennsylvania, and one of the most interesting of all chemists is its director, Dr. E. R. Weidlein. The fascination of the great laboratory and its director are both due, in part, to the fact that their work keeps them about two jumps ahead of the innumerable applications of chemical engineering to industry, for the Mellon Institute is the scene of hundreds of scientific conquests that later find their way to the public in the form of improved products.

Manufacturers, groups of manufacturers in similar fields, and even trade associations establish fellowships at the Institute, making it possible for some highly trained chemist or engineer to concentrate on the particular technical problems that they are most anxious to have solved. At the present time there are 63 industrial fellowships, relating either directly or indirectly to almost any business that can be named. Now Director Weidlein announces that a monumental new home for Mellon Institute, illustrated herewith, will be started this fall.

When the present home of the institute was completed, in 1915, it was felt that the industrial fellowships procedure created by Robert Kennedy Duncan had passed from the experimental to the practical stage. The building, which was given to the Institute by Andrew W. and Richard B. Mellon, incorporated the best laboratory constructional features of that period. It was thought then that it would provide adequate space for growth for many years; but for practically 10 years the institute has had a waiting list of companies, often almost as long as the roster of companies whose problems were being investigated.

In addition to providing a greatly increased number of laboratories, the new building will give more commodious quarters for general departments. The present library contains 11,000 volumes; the new library is planned to accommodate 250,000 volumes. The present Department of Research in Pure Chemistry will be expanded and facilities for pure research in other branches of science will be provided. Much more elaborate chemical engineering laboratories are to be available in the new building, and also the fellowships in each specific field of industrial research are to be grouped in suites of rooms so that they can best make use of general apparatus adapted to their needs. Certain rooms will be equipped for specialized phases of experimental technique, such as electrochemistry, spectroscopy, low-temperature studies, radiations, high-pressure experimentation, and so forth. Other special features to be included are a large lecture hall, a dining hall, an industrial fellowship museum, and an underground garage. For the past five years, members of the institute's executive staff have been visiting laboratories in America and Europe to obtain information on new features in design and equipment.

The new laboratory structure will be of that type of classical Greek architecture known as Ionic. It is to be seven stories high, with monolithic columns along all four sides. The proportions will be approximately 300 by 400 feet. The main entrance, which is located on the third floor, is reached by steps extending along the entire front of the building. The laboratories are to face on interior courts. The design of the new building is to be such that additional laboratory suites can be constructed in the interior courts without marring the beauty of the general appearance and without interfering in any way with the original laboratory units.—*A. E. B.*

BASEBALL PITCHER'S ELBOW

WHEN a baseball pitcher winds up to pitch a ball, the arm and forearm should be held in extension and the throwing of the ball should be from the shoulder. Sometimes, during the wind-up, a pitcher will hold his arm slightly flexed; then as he prepares to throw the ball, by suddenly and forcibly contracting the muscles in the back of the arm and rotating the forearm and hand inward and downward to give speed to the ball, he extends his forearm rapidly. In the maneuver the head of the large bone of the forearm is brought backward suddenly and with great force against the large bone of the upper arm. As a result, a small piece of cartilage and bone from the head of the radius, the large bone of the forearm, may be chipped off, will remain about the joint, and be constantly irritating and troublesome with every movement.

The average velocity of a baseball after it leaves the pitcher's hand is about 90 feet a second. This will give some indication of the force involved in the production of this injury.

Dr. F. J. Kirby has reported two cases

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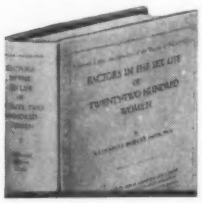
FACTORS IN THE SEX LIFE OF 2200 WOMEN

By Katharine Bement Davis, Ph. D.



This pioneer volume offers concrete factual data on the events in the sex life of normal women, supplying needed information on a topic which has long been the subject for uninformed conjecture.

Under the expert direction of Dr. Davis, two groups of selected women—married and unmarried—replied anonymously to questionnaires designed to elicit information on every phase of woman's sexual life. Full data on the various periods of life, as well as on so-called "abnormal" experiences were received.

This information was first tabulated. Then comparative statistical studies were made on the most important topics. The book offers specific data on many questions like: What factors seem to enter into the "happy" and "unhappy" married life? What are the causes and extent of abnormal practices? What is the importance of sexual education, etc.?

The clear and simple treatment makes the book invaluable to social workers, physicians, parents, educators; first in developing a saner attitude toward the whole subject; second as a tested method in throwing light on sexual maladjustments as affecting personal relations.

The SCIENTIFIC AMERICAN says: "Almost to a certainty this book will upset a number of fondly cherished beliefs. It is a thoroughly scientific record of scientific work in sociology, performed by a noted scientific authority. The discoveries recorded were based on actual data secretly obtained." For free examination, use the coupon now. Price $3.50.

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of this character which came to his attention. In both, unfortunately, it was necessary to open the joint and to remove the small piece of bone in order to relieve the patient from constant difficulty in movement. Just as soon as the loose portion of the bone is removed and the operation wound heals, the patient is likely to recover fully.—*M. F.*

400 TONS OF BOTTLES A DAY

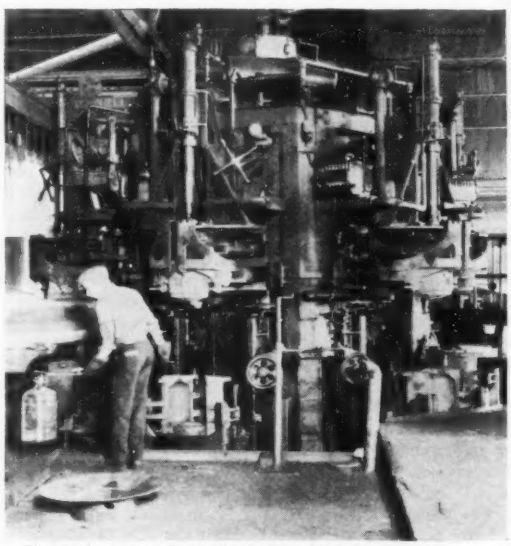
GLASS bottles! How often they play their unobtrusive rôles in little dramas of modern life: The message floating at sea in a stoppered bottle; the tiny vial of serum rushed to save a life; the "pop" bottles at the ball park and the road stands; the daily milk bottles; the bottles that gleam in the chemists' laboratory, on the barber's shelf, in the drug store, the grocer's, the stationer's. It is hard to realize how completely our comfortable modern life would be disorganized if glass bottles were suddenly taken away from us.

Until comparatively recently, all glass bottles were blown by hand or, rather, by mouth. A "gob" of molten glass was balled around the end of a blow pipe, by a skilful glass blower, and the bottle blown by lung power into a mold which gave it the desired shape. The demand for more and cheaper bottles has spurred the glass technologist and the mechanical engineer to convert the age-old process to a highly refined machine operation, until today, we find at Alton, Illinois, a single factory which produces 300 tons of machine-blown bottles per day. The bottles produced here by the Owens-Illinois Glass Company include over 3200 different styles and sizes.

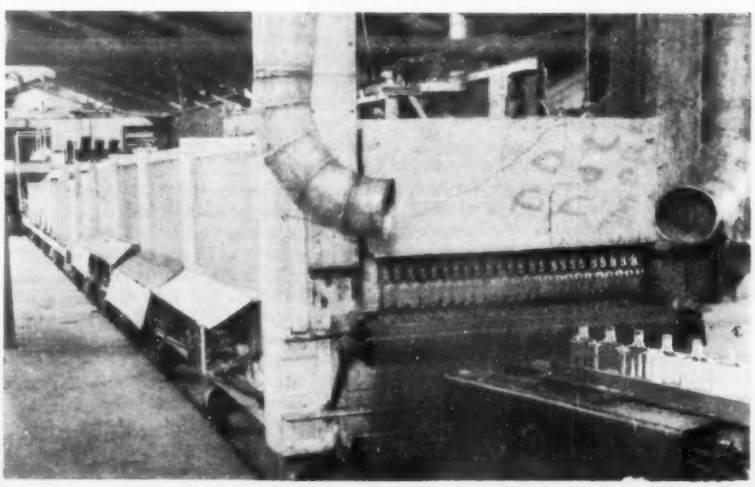
The molten glass fed to bottle machines must be exactly right in composition. Expert chemists control every step in its manufacture. In addition, finished bottles are inspected with instruments so delicate that the internal strains set up in the glass by holding a lighted match near the bottle can be readily discerned.

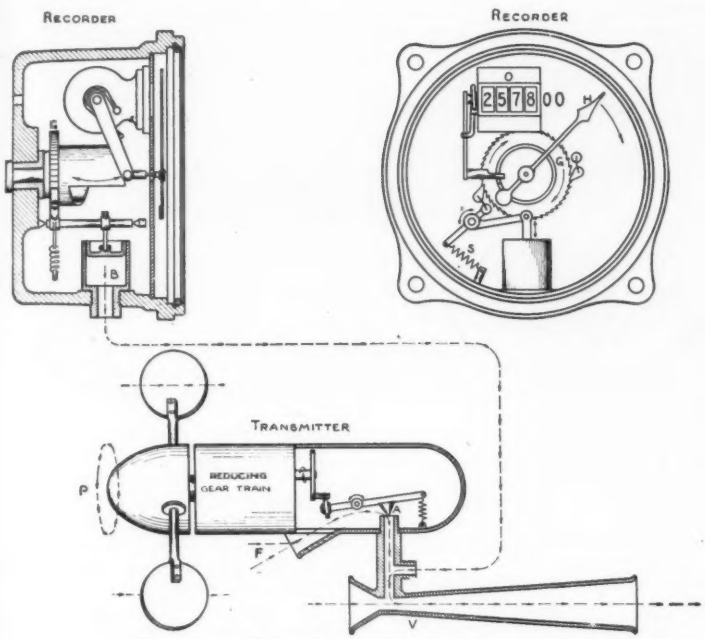
In the research laboratory of the company there is a collection of instruments not frequently found in an industrial laboratory. Among them is a specially constructed precision interferometer which is used in detecting sub-microscopic cracks in glass. An Abbe-Fizeau interferometer, regularly applied to the determination of the coefficient of expansion of glass, has been specially modified to adapt it to the determination of the softening point and heat conductivity of glass in addition to its regular function. The study of the structure of complex silicates is aided by means of an X-ray reflection apparatus. A precision Ruprecht

Right: **Largest bottle blowing machine in the world. It is a six-head, vacuum-feed type, standing 20 feet high and weighing 120 tons. The revolving pot of melted glass is just to the left of the attendant who is removing a five-gallon carboy from its mold.** ***Below:*** **The feed end of an electrically heated lehr, in which the bottles are annealed**



Photographs courtesy Owens-Illinois Glass Company





This new air log indicates airplane miles traveled

balance is used to determine slight losses in weight due to the solubility of glass, whole bottles being used in the experiments.

Machine-blown bottles furnish a striking and dramatic example of the mechanization of an ancient industry, made possible by the combined genius of scientists and engineers.—*A. E. B.*

USE OF ELECTRICITY DOUBLED

PER CAPITA use of electric power in the United States has more than doubled in the last ten years, according to statistics based on the 1930 census, says F. E. Bonner, executive secretary of the Federal Power Commission.

The figures show that for the entire country, the per capita use increased from 391 kilowatt-hours in 1920 to 800 kilowatt-hours in 1930.

THE AIR LOG

THERE is nothing more interesting on board ship than to lean over the taffrail and watch the log do its endless work of recording distance. The corresponding aircraft instrument, the air log, is less frequently employed. Its greatest value lies in long flights as an aid to navigation. It is also very useful for such records as fuel and oil consumption, mileage between overhauls, and other data of interest to the transport operator. The air log or air distance recorder as now built by the Pioneer Instrument Company, is an ingenious and interesting mechanism.

It consists of two parts—the transmitter and the recorder. In a biplane, the transmitter is mounted on one of the outer interplane struts, while on a monoplane it is mounted three feet or more ahead of the leading edge of the wing, so as to be free to some extent of the air-flow disturbance caused by the wing. The recorder is mounted on the pilot's instrument board. The two units are connected by a small copper tube. The basic principles of the recorder are clearly illustrated by the accompanying drawings.

The flow of air through the venturi tube V causes a suction at its throat or narrowest section, where the air must flow with its greatest velocity. This suction is carried through the copper tube to the piston B in the recorder, and pulls down the piston B against the action of the spring S.

The flow of air, as the plane moves forward, also rotates the flat disk propeller P, in the direction shown by the circle and arrows. The pitch of the propeller and the ratio of the gear train in the transmitter are such that the valve A is opened once every mile. This allows air to flow in at F and breaks the suction in the line. Once the suction is broken, the spring S pulls the piston B up to the top of its stroke, the position shown in the drawing. Simultaneously this causes the pawl to move the gear G one tooth, carrying the hand H on the recorder dial one unit forward. Valve A is then closed and the piston is once again sucked to the bottom of the cylinder ready to repeat the action at the end of the next mile.

The gear G has 100 teeth so that the hand makes one complete revolution for every 100 miles traveled. The gear also rotates a spiral cam causing the counter arm to move and indicate another hundred miles while the hand H continues on the next revolution. Total mileage flown is obtained by adding those shown by the counter and the hand. The mileage for a given trip is obtained by noting readings at the start and end of the trip.—*A. K.*

A NEW PORTABLE POWER UNIT

A PORTABLE electric power plant, weighing 120 pounds and capable of delivering 1000 watts, has been developed by the Westinghouse Electric and Manufacturing Company. This plant is provided with duralumin skids which make it easy to transport. It is powered by a gasoline

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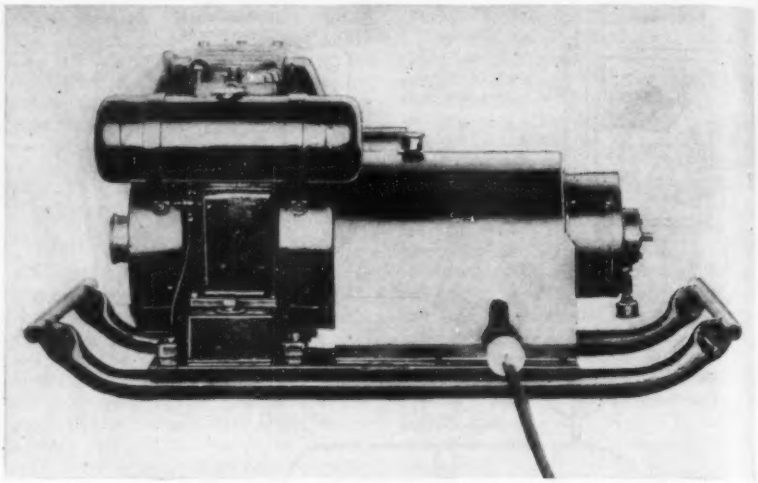

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SHORT REVIEWS OF BULLETINS AND PAPERS ON SCIENTIFIC AND ALLIED SUBJECTS, AND WHERE TO GET THEM

HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO, REPORT FOR 1929 is an important treatise on co-operative municipal-ownership power enterprises. Practically the whole province of Ontario is being supplied with Niagara Falls power at cost. There are excellent maps and a wealth of data. *Hydro-Electric Power Commission of Ontario, Toronto, Canada.—$2.00.*

GEOLOGY AND WATER RESOURCES OF THE KAU DISTRICT, HAWAII (U. S. Geological Survey Water Supply Paper 616) is a misleading title, for the pamphlet is mainly descriptive of the geology of Mt. Kilauea where Dr. T. A. Jaggar maintains the United States Volcano Observatory. *Superintendent of Documents, Washington, D. C.—85 cents (money order).*

BOOKLIST BOOKS 1929, A SELECTION, gives the most important list of the new books giving brief notes as to their value together with the number of pages and the prices. It is accompanied by a complete index. *American Library Association, Chicago.—65 cents.*

AERONAUTICS TRADE DIRECTORY (Aeronautics Bulletin No. 3, Aeronautics Branch, U. S. Department of Commerce) is a most valuable booklet dealing with commodities and activities. It gives a complete list of manufacturers of airplanes, accessories, airport designers and constructors, engine manufacturers, hangar builders, and all the thousand and one items that go into this industry. It also gives a complete list of air-transport operators and aeronautical engineers. *U. S. Department of Commerce, Aeronautics Branch, Washington, D. C.—Gratis.*

NATIONAL PHYSICAL LABORATORY REPORT FOR 1929 is a 300-page book giving a description of a year's research at Great Britain's "bureau of standards." It deals with heat, radiology, sound, optics, electricity, measurement, and general research. *His Majesty's Stationery Office. London, England.—Eleven Shillings.*

THE ATMOSPHERE AND THE SUN (Smithsonian Miscellaneous Collection, Vol. 82, No. 7 by H. Helm Clayton) gives further scientific evidence of weather cycles, their causes and interpretation, with a particular view to long-range weather forecasting. *Smithsonian Institution, Washington, D. C.—25 cents.*

EARLY PUEBLO RUINS IN SOUTHWESTERN COLORADO (Bulletin No. 96, Bureau of American Ethnology, Smithsonian Institution) by F. H. H. Roberts, Jr., is a 180 page account of archeological work done in 1928, with a brief history of early American cultures. Illustrated. *Superintendent of Documents, Washington, D. C.—75 cents.—Money order.*

AUTOMATIC ARC WELDING BY THE ELECTRONIC TORNADO PROCESS is a monograph on an accepted method for manufacturing pipe, tanks, boilers, and similar equipment when the production is sufficiently large to justify the cost of equipment. *The Lincoln Electric Company, Cleveland, Ohio.—Gratis.*

HINTS ON COYOTE AND WOLF TRAPPING (Leaflet No. 59, U. S. Department of Agriculture), *Superintendent of Documents, Washington, D. C.—5 cents, coin.*

MODERN METHODS IN REPAIR SHOPS is a large and beautifully illustrated monograph of 120 pages dealing with cranes, turn tables, car washers, and other devices useful in car shops, roundhouses and terminals. Free to interested parties. *Address Whiting Corporation, Harvey, Illinois.*

THE SURFACE WATERS OF MICHIGAN (Engineering Research Bulletin No. 16, Department of Engineering Research, University of Michigan) by Robert L. McNamee, outlines the hydrology and qualitative characteristics and purification of water for public use. Accompanied by an excellent series of maps. *Department of Engineering Research, University of Michigan, Ann Arbor, Mich.—$1.50.*

THE INDUSTRIAL MUSEUM OF NEW YORK describes an exhibit of early astronomical and mathematical instruments. It also describes the David Eugene Smith collection and contains a monograph on the Astrolabe by Jekuthiel Ginsburg, A.M., and on (Sun) Dialing by J. Ernest G. Yalden. *Museum of the Peaceful Arts, Daily News Building, East 42nd St., New York City.—Gratis.*

THE HIGH SCHOOL SCIENCE LIBRARY FOR 1929-30 by Hanor A. Webb gives the titles of the very newest books in the field of science on the junior and senior high school level. *Address Hanor A. Webb, George Peabody College for Teachers, Nashville, Tennessee.—10 cents.*

CONSERVING VISION IN INDUSTRY (Publication No. 68) contains several interesting signed papers. *The National Society for the Prevention of Blindness, 370 Seventh Ave., New York City.—25 cent..*

FORMATION AND PROPERTIES OF BOILER SCALE (Engineering Research Bulletin No. 15, Department of Engineering Research, University of Michigan) by Everett P. Partridge, is an elaborate discussion of the subject, accompanied by a full bibliography. *Department of Engineering Research, University of Michigan, Ann Arbor, Mich.—$1.00.*

SAFETY CODE FOR BRAKES AND BRAKE TESTING (Miscellaneous Publication No. 107, Bureau of Standards, Department of Commerce) gives valuable results which have been approved by the American Standards Association. *Superintendent of Documents, Washington, D. C.—5 cents, coin.*

SPICES AND CONDIMENTS (Leaflet No. 15, Field Museum of Natural History, Department of Botany) by James B. McNair, Assistant Curator of Economic Botany, is a valuable pamphlet fully illustrated and gives much out-of-the-way information. *Field Museum of Natural History, Chicago, Illinois.—25 cents.*

THE RUN OF THE TWENTIETH CENTURY, by Edward Hungerford, is one of the most illuminating publications on railroad service we have ever seen. It is accompanied by excellent diagrams and illustration. *New York Central Lines, 466 Lexington Avenue, New York City.—50 cents.*

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING gives valuable information as to retirement and pensions. *Carnegie Foundation for the Advancement of Teaching, 522 Fifth Avenue, New York City.—Gratis.*

ARTIC, THE REFRIGERANT (Technical Paper No. 274) is a small treatise on the physical properties and performance data of Artic. Of value to anyone interested in refrigeration. *The Roessler & Hasslacher Chemical Co., Niagara Falls, N. Y.—Gratis.*

OUR POINT OF VIEW

(*Continued from page 349*)

of our Navy as a matter of course; actually it is the result of generations of systematic effort. The naval routine which trains American lads to become able seamen and capable petty officers, and develops midshipmen into captains and admirals is exacting. The naval exercises which gradually convert an aggregation of ships into a fighting fleet instantly responsive to the will of its commander, are arduous and unending.

The peace-time preparation of the fleet is carried on at sea or isolated anchorages, with none of the glamor of battle or the stimulus of war; it would become plain drudgery except for the animating spirit of the Navy that has been handed down from Paul Jones.

Pay the Navy personnel a visit on their annual day at home. Your interest will stimulate their future endeavors, and we believe you will come away a better American and more conscious of your obligations as a good citizen. The Navy selected Theodore Roosevelt's birthday for their annual day at home because that stalwart American devoted himself to increasing the efficiency of the fleet. Whether you are able to visit the Navy or not, remember his famous maxim, "Speak softly, but carry a big stick."

Great Britain Taken to Task by League of Nations

THE Mandates Commission of the League of Nations is apparently taking its duties seriously, for it recently criticized the British Government severely for its failure to foresee and prevent the recent conflicts between Jews and Arabs in Palestine. Mr. Henderson, British Foreign Secretary, made a tart rejoinder and asserted that the Mandates Commission itself did not foresee these outbreaks although kept fully informed of

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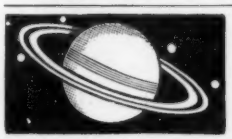

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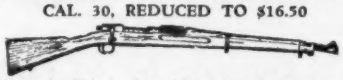

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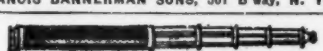

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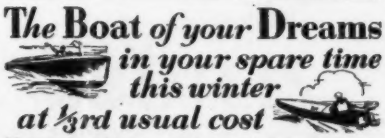

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conditions in Palestine. The exchange of notes will probably close the incident, for the League can scarcely be expected to take punitive steps against Great Britain.

Cynics have hitherto regarded "mandates" as a euphemism for "colonies" but the action of the League officials in the Palestine riots opens interesting future possibilities. And if the League dares to rebuke Great Britain, who with some justice prides herself on her ability as a colonial administrator, it will probably not hesitate to intervene in other instances.

The lot of present day Colonial Ministers is not easy, but if, in addition to answering the petitions of backward peoples clamoring for self-determination, they can be summoned to Geneva to give an account of their stewardship, additional troubles are in store for them.

There has been considerable discussion in England concerning the extent of her liability under the Covenant to use her Navy to enforce a decree of the League. Whose Navy *can* the League call upon to enforce a reform of a British mandate?

This incident, almost trivial in itself, illustrates the helplessness of a League of Nations; if the League authorities had the power to enforce their decisions, the world would be in the grip of a despotism just as real as the Roman Empire; without the power to enforce its decrees against a first rate state, the League can never be more than a common international scold.

Pilsudski and Poland PARLIAMENTARY government has received another setback in Europe. This time Poland chose to trust in its famous Marshal who turned back the Bolsheviks before Warsaw in 1920, rather than in a noisy, factious parliament.

There is nothing in the tragic history of a brave but politically unstable people to indicate that a parliamentary system will preserve Poland from internal disorders or external foes. Her first partition was made possible by factional jealousies and a constitution better adapted to protect Poles from their rulers than Poland from three land-hungry Emperors, possessed of well-equipped armies and endowed with power to use them at will. Poles, having to choose between an inefficient government under representative forms, and a Dictatorship which promises a strong but efficient government, have, like Italy, Jugoslavia, and Rumania, chosen the Dictator.

South American Revolutions THE exile of former President Irigoyen from Argentina is the climax and, we hope, the end of a series of revolutionary outbursts in South America.

Almost simultaneously the governments of Peru and Argentina were overthrown by successful revolts; the government of Bolivia had suffered a similar fate a few months earlier. Whatever may be the causes of these outbreaks, it is apparent that many South Americans still prefer to determine their elections with bullets.

We can not be indifferent to the customs of our Spanish-American neighbors. Peru, in particular, has been on peculiarly friendly relations with our country, and her recently deposed President Leguia was proud to proclaim his friendship for the United States. American mediation was instrumental in restoring one of Peru's lost

provinces to her and in reducing the friction between Chile and Peru.

An American Naval Mission has been assisting the Peruvian Government to increase the efficiency of her Navy, and American capitalists have invested large sums to develop the mineral wealth of that small but richly endowed state.

As President Leguia became President by a military usurpation and retained power by military coercion, it will be easy for caustic critics to point the moral, but as during his long tenure Leguia gave his country domestic tranquillity and effected a settlement of the long-standing dispute with Chile, we hope his triumphant opponents will allow him an honorable exile and spare their new régime the needless stain of placing Peru's former President before a firing squad. As our State Department was willing to be considered his friend while he was in power, it should not hesitate to go to his assistance in his distress.

Argentina's deposed President, Irigoyen, prided himself on defying the United States, so in a negative way our relations with Argentina should improve by his deposition. Argentina has more trade with Great Britain than with the United States and many of her important industries are owned by English capitalists. There is a British-Argentine trade association actively engaged in fostering trade between the two countries. This association is preparing an exposition of British goods, to be held in Buenos Aires next year, and the British Government has shown its interest in the success of the exposition by agreeing to send the Prince of Wales as its representative.

England buys much of Argentina's meat and wool and sells manufactured goods to that country. One of the reasons urged against a British Empire preferential tariff is the large Argentine trade that would be adversely affected if Argentina were left outside the British tariff wall.

Mexico

AGAINST the revolutions in South America should be placed the orderly opening by President Rubio of the 34th Mexican Congress. He predicted that Mexico had definitely entered upon an era of peaceful reconstruction. Americans, although not so optimistic as President Rubio, will wish their southern neighbor well. No other country has so large an interest in Mexico's stability and prosperity; and our long forbearance should, by now, have convinced Mexico's rulers that we have no sinister designs on her territory and only wish to see her peaceful and prosperous.

Both Cuba and Panama have shown restlessness under their present rulers, and but for their treaty relations with us, would, undoubtedly, have gone the way of Peru and Argentina. The editor of a paper in Panama regrets that their relations with the United States prevent Panamanians from indulging in revolutions, that are open to all other Spanish-American countries; he extols the freedom of action open to a dictator to achieve reforms unhampered by a laggard legislature; and has nothing but pity for an executive who is under the mortifying necessity of soliciting the ballots of his fellow-countrymen. When we feel superior about our electoral customs, we should remember that many other peoples have little faith in ballots.

FOOTBALL

(*Continued from page 372*)

one-sided to give the new plan a fair trial.

As to the first of the foregoing points brought out in favor of the system, the losing team never had the ball in its possession during the last 20 plays. Concerning the second point, there can be no doubt of the value of the plan—the stop-watch is entirely unnecessary, and all that is required of the official timer is that he be able to count up to 40.

From the spectator-interest standpoint, this test game seemed to prove there was *less* interest shown, which, of course, may have been due to the uneven score. However, using the period-by-play system, in place of the interval elapsed, there is more of a tendency on the part of the players to waste time between plays. When this occurs the number of plays per minute is decreased, and spectator interest tends to wane. In the Brown-Boston University game, the number of plays in both the third and fourth quarters was reduced from 40 to 35 because of approaching darkness.

The data for the eight games studied indicates that the average number of plays per quarter consistently increased slightly in each succeeding quarter, which is as might have been anticipated. As soon as the losing side sees the end of the game is coming nearer, they invariably speed up their game; they lose little time in giving signals and in shifting formations. Thus the average number of plays in the first quarter was 40.3, 41.3 for the second, 41.5 for the third, and 42.9 in the last. The actual time the ball was in motion in the first quarter averaged 2 minutes 55 seconds, and 3 minutes 19 seconds in the last.

A complete chart of the 1929 Army-Notre Dame game at the Yankee Stadium in New York City last November appears on page 371. This chart shows in detail the plays made by each team as the game progressed. The legend, giving the symbols used, is located in the upper left hand corner.

In this very interesting and exciting game not a single forward pass was completed. However, Notre Dame intercepted three of the Army's passes, one of which ended in Elder's famous run and touchdown—the kind of a run that sinks and stays in the mind of the average football fan for years.

Applying Coach Glenn Warner's system of scoring—which awards a point for every first down made and eliminates the try-for-point after a touchdown—the score in this game would have been 12 to 5 in favor of Notre Dame. The Southbenders made six first downs and the West Pointers five. The difference in scores under the Warner method would have been seven, which was the same margin by which Notre Dame won using the orthodox method of scoring.

The two vertical black bars at the right-hand side of the chart represent the time the ball was actually in motion, and the time elapsed from the initial kick-off to the end of the game. The bars emphasize graphically the large difference between the playing time and the elapsed time; it will be observed that the latter is about 10 times the former, which visually explains the statement that you pay about twenty-five dollars per hour to watch football.

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BETTER MAILING CONTAINER SOUGHT

SAFER and lighter packing for parcel-post shipments in the international mails would help to increase American export trade in liquid preparations, according to a statement just made public by the Department of Commerce, prepared by Thomas E. Lyon, Assistant Chief of the Department's Transportation Division.

A method of packaging by a manufacturer of pharmaceutical goods is described in the statement, which follows in full text:

During the year 1929 the United States exported medicinal and pharmaceutical preparations to the total value of 21,282,000 dollars. More than one-half of this sum, or 11,655,000 dollars, composed medicinal preparations for internal use, which usually are shipped in bottles and distributed in small units. This last figure could be considerably augmented by other liquid preparations, such as hair tonics, toilet preparations, and so forth, which are usually sold in similar packages. While a considerable part of this trade is shipped by freight, American exporters have felt that it could be increased if parcel-post shipping conditions were improved. Heretofore it has been necessary in making parcel-post shipments to fill packages with sufficient absorbent material to take up any leakage caused by breakage; the absorbent material, as a rule, exceeded the actual weight of the commodity shipped, and thereby increased parcel-post charges.

A well known manufacturer of pharmaceutical goods recently carried on a considerable series of experiments with a view to improving his parcel-post package and has succeeded in developing an economical package which meets the requirements of the Post Office Department. He has furnished the Bureau of Foreign and Domestic Commerce with a description of this package, as follows:

At first a number of experiments were made with various forms of absorbent material packed around the bottles, the outer container being either waterproof or lined with a waterproof material. None of these produced a satisfactory package, however, and finally this idea was discarded and the work directed toward finding some sort of container or case which would adequately protect each bottle.

Obviously a case was required which would be light, very strong, waterproof, and not too expensive, and inside of this case must be placed a sufficient amount of some absorbent material to take care of the loss of the entire contents of the bottle, if necessary.

The form of protection finally adopted for each bottle was a five-ply fiber-board round mailing case, paraffin-sprayed both inside and out, and with a metal screw cap. The fiber-board of which it is made tests 295 pounds on a standard Mullen tester.

A feature of this case is the fact that the threads which engage the screw cap when the case is closed are formed in the fiber board itself during the process of manufacture, instead of being made of metal and fastened to the top of the tube. Such a method of construction insures an extremely tight closure when the cap is screwed down, for then the top of the fiber tube is pressed very closely against the inside of the metal cap, and, being of softer material than the cap, gives just enough to produce the same effect as if a washer were used. This case was found to be absolutely water-tight under tests conducted over a considerable period of time and with the package in various positions.

The absorbent materials ordinarily used, such as bran, sawdust, and so forth, were all unsatisfactory, and the material finally adopted was crêpe wadding. In using this material it was found that no corrugated liners, pads, or disks were necessary.

In assembling the packages for shipment, sheets of crêpe wadding were first procured of such a size that they were about six inches longer than the bottles, and wide enough to produce an overlap of at least two inches and cause the bottles to fit snugly in the cases. Each bottle was then placed in the middle of a sheet, the material was rolled around it, the two ends were tucked in, the wrapped package slid into the case, and the metal top screwed down tightly. The 12 individual cases were then placed in the corrugated box, and the box sealed with sealing glue under pressure in the customary manner.

The complete box, holding one dozen eight-ounce bottles, weighed 17 pounds 15 ounces. The standard export case, containing six dozen of these same bottles, weighs 120 pounds, or 20 pounds per dozen. In spite of the additional protection given the individual bottles by this method of packing, the total weight per dozen has been reduced over 10 percent.

"U. S." ENDORSEMENT IS FALSELY CLAIMED

FALSELY asserting that their respective products had received endorsement of the United States Government, a beverage manufacturer and a correspondence school signed stipulations with the Federal Trade Commission agreeing to cease the practice. The beverage company also misrepresented the qualities of its product.

Details of stipulations are as follows:

(1.) Statements which do not truthfully describe the properties and powers or the curative and therapeutic effects to be derived from use of a certain beverage will no longer be inserted in the advertisements of a corporation manufacturing such beverages.

The company will also cease representations which imply that the beverage has been approved by the United States Government, and will discontinue assertions to the effect that the preparation is used in government and other hospitals and in sanitariums and is prescribed by physicians and dieticians, unless and until such averments are substantiated by fact.

(2.) Representations tending to confuse the public into the belief that its home study courses of instruction in aviation have the approval of, or are rated, inspected, or graded by the United States Government or have the official endorsement of authorities in aviation, when such is not the fact, will be discontinued by a corporation conducting a correspondence school.

GOLF TAX NOT APPLICABLE TO MINIATURE COURSES

SO-CALLED "miniature golf" has no intrinsic relationship, though there are points of similarity, to the recognized game of golf, according to a ruling of the Supreme Court of the District of Columbia.

A license for the operation of the miniature game, therefore, Chief Justice Wheat of the court ruled, may not be exacted under the provision of the District of Columbia licensing act providing for the payment of a license fee of $5 a day for a golf course or kindred game.

The court directed the issuance of a mandamus against Wade H. Coombs, superintendent of licenses, requiring him to grant a license to the operator of a "miniature golf course" under another provision of the licensing act providing for the fee of $100 annually.

The name, Chief Justice Wheat stated, had nothing to do with making the game kindred to golf, pointing out that sometimes a game of dice is known as "African golf."

TRADEMARKS IN FOREIGN LANDS

THE influence of the common-law theory of property rights in trademarks, writes James L. Brown, Chief of the Patent and Trademark Section, Division of Commercial Laws, Department of Commerce, in a recent issue of the *United States Daily*, is noticeable to some extent in many countries where the common law does not generally prevail.

A recent case in one of the Slavonic countries called to mind the recognition given to certain industrial property rights regarded as inherent by the common law and not so recognized in countries where the civil law forms the basis for jurisprudence. A similar instance in Panama brought to light the fact that the theory of exclusive property right in the first user of a trademark limited to an extent the generally understood meaning of the term "first user." With the expansion of inter-

national trade, many of the countries not having the common law system of jurisprudence have given recognition to the intangible property right in trademarks by virtue of prior use.

The American exporter is often confused, if not misled, by the expression of the term "prior user" when considering the rights in trademarks, labels, or other means by which he identifies his products shipped abroad. Considering this expression from a general viewpoint, it would seem that he who first adopts and uses a mark in connection with his goods would generally be considered as a prior user and within the expression of the laws of most foreign countries that a prior user is entitled to the registration and exclusive use of a trademark.

It must be understood that provisions in foreign trademark laws protecting the rights of a prior user are intended to cover only prior use within that particular country and, although one has adopted and is the prior user of a trademark in his home country, the property right acquired thereby is not extensive to other countries where the rule of prior user prevails. It is often because of this misunderstanding regarding such provisions in foreign laws that foreign dealers are able to acquire the right to register a trademark and thereby its exclusive use.

In this connection, however, the laws are not uniform and the right acquired by prior user in many of these countries is recognized only for a limited period of time; that is, the prior user may have a registration by another or subsequent user set aside within a given period of time after the registration has been effected. This period of time in which to oppose a registration by a subsequent user varies from 30 days to three years.

While the American exporter should give particular attention to the protection of his marks in the countries where the first applicant of a trademark is entitled to its exclusive use, he should not be unmindful of the necessity of giving earnest consideration to the question of the protection of his mark in the countries where the prior user will prevail. In practically all countries of that group in which the prior user of a mark is entitled to the registration and the exclusive use thereof, it is also advisable to obtain registration since this is prima facie evidence of ownership and may be required in any action for infringement that may be brought later.

Despite the attention that has been given by the American exporter to the intangible right in industrial property in foreign countries, whether it be in the nature of obtaining patents for inventions and useful discoveries; copyright and literary and artistic works; or registration of trademarks, trade names, labels, and containers; there is a steady increase in the tendency abroad to profit by the good will established through advertising and other media by simulating American products and their means of identification.

PUBLICATION TITLES DENIED REGISTRATION

FIRST Assistant Commissioner Kinnan has held that the Fawcett Publications, Inc., of Robbinsdale, Minnesota, is not entitled to register either the words *Modern Mechanics* or the words *Modern Mechanics and Inventions* as trademarks for magazines in view of the prior use by Popular Mechanics Company, of Chicago, Illinois, of the term *Popular Mechanics* as a trademark for a magazine.

The ground of the decision is that the goods are the same and the marks as applied thereto are confusingly similar.

In the decision, after stating that the opposer had used its mark for over a quarter of a century prior to the adoption of the mark by the applicant, had established a large circulation and spent considerable sums of money in advertising, and that if there is a doubt it must be resolved against the newcomer, the First Assistant Commissioner said:

"It is believed this case is controlled by the decision in the case of New Metropolitan Fiction, Inc. v. Dell Pub. Co. 364 O. G. 778, 57 App. D. C. 244. In this case application was made for the registration of the words *Modern Marriage* as a title for a monthly magazine. The opposer proved priority of adoption and use of its registered marks *Marriage* and *Marriage Stories*, (quoting from the decision). The court further referred to the holdings in the cases of Vogue Co. v. Brentano's, 261 Fed. 420, in which the trademark *Vogue* as the name of a magazine was held to be infringed by the use of *La Vogue Parisienne* as the name of another publication, and Art Metal Const. Co. v. Textile Pub. Co., 54 App. D. C. 75, in which the name *The Office Economist* was held confusingly similar to the name *Dry Goods Economist* when used upon similar publications.

"It is clear enough, and the testimony supports the conclusion, that confusion will result from the use of these two names upon the respective magazines."

INVENTOR NEED NOT UNDERSTAND REACTION

IN a recent appeal from the decision of the examiner finally rejecting claims 1 to 5, inclusive, and claims 8, 9, and 10 on a patent recently issued, Shannon Smith, patentee, emerged victorious. Claims 1 and 3 are illustrative of the subject-matter on appeal:

1. A composition of matter for cutting back bituminous material of the character described, said composition including a mixture of quicklime and Glauber's salt in the proportions of substantially nine parts of quicklime to one part of Glauber's salt.

3. A composition of matter for cutting back bituminous material of the character described, said composition comprising light oil and a mixture of quicklime and Glauber's salt in the proportions of substantially nine parts of quicklime to one part of Glauber's salt.

The references relied upon by the examiner are:

Amies (Br), 9929, of 1909; Erwin, 1409088, Mar. 7, 1922; Amies, 951471, Mar. 8, 1910.

Each of the appealed claims is comparatively specific, drawn to a composition of matter for cutting back bituminous material and including a mixture of quicklime and Glauber's salt. Some of the claims include additionally specific proportions of these ingredients and a light oil.

This specific composition of matter for the stated purpose is not disclosed in either of the cited patents. The nearest approach to a disclosure of such composition is found in the Erwin patent, but this patent is indefinite as to the character of the lime employed and fails to disclose the use of Glauber's salt.

The contention of the examiner to the effect that sodium sulfate, broadly considered, referred to in the references, is the same as Glauber's salt, has no basis in fact, Glauber's salt being a specific form of sodium sulfate.

As the applicant's composition is specifically new and as it possesses advantages in the particular use to which it is employed over the compositions disclosed by the references, no reason is apparent why the appealed claim should not be allowed.

With reference to the examiner's contention in his supplemental statement to the effect that the explanation contained in the affidavit of James F. Carle that there is a reaction between the quicklime and Glauber's salt, wherein the quicklime takes up the water of crystalization of the said salt, thereby absorbing a portion of the heat evolved by the slaking of the quicklime to such a degree that the light oils of the bituminous materials are not evaporated, is inconsistent with the specification and claims, which make no mention of such a reaction, it may be stated that such contention is without basis in fact. The claims on appeal are wholly consistent with the original disclosures and the original claims. They are perfectly definite as to the character of the composition and its use upon the bituminous material. They are addressed to one skilled in the art and to practice the invention it is only necessary to employ the described composition in the described manner. An inventor is not required to understand the chemical reactions which take place in a composition, a disclosure of the composition and how it is employed constituting a full compliance with the law (section 4888 R. S.).

The decision of the examiner is reversed.

PAPER TRADE MEN QUIT UNFAIR COMPETITIVE METHODS

WITHDRAWALS of unfair competitive practices in the paper trade are reported by the Federal Trade Commission in two stipulation proceedings, one with a publisher of a monthly magazine devoted to the interests of the paper and pulp trade, the other with a company dealing in paper products.

Details of these particular cases are as follows:

(1.) The publisher of a monthly periodical devoted to the interests of the paper and pulp trade will no longer republish or reproduce printed material published by his competitors when such purported reproduction is not complete, unless he prints along with such information notice to the effect that it is not complete.

(2.) Use of the word "mills" in advertising will be discontinued by a corporation selling and distributing paper products so as not to deceive buyers into the belief that the company owns or operates a mill in which the products sold by it are made, according to a stipulation agreement between the company and the Federal Trade Commission.

BOOKS SELECTED BY THE EDITORS

THE PERSON OF EVOLUTION—*By W. D. Lightall, LL.D.*

THIS is not a book on evolution as the word generally is used, but on philosophy. Science does not attempt to go behind appearances, while philosophy does. Within the past five years a growing group of the world's ablest, most profound men of science—Compton, Millikan, Russell, Wheeler, Whitehead, Eddington, Smuts, Haldane, Needham, and others in high circles—have invaded the domain of philosophy and, though they differ somewhat in their interpretation, their thought centers around what might be called a scientific "religion" of "emergent evolution." Of this new trend, which rationalizes the more common emotional, revealed type of religion, the book under review is a splendid summary of 216 pages.

The central idea is, that the whole Universe, whether "inert" or living, is evolving toward a definite goal, imbued with a reasoning, directive, purposive power or "Outer Consciousness," the "Person of Evolution." Of this superpersonality or composite reasoning being, all lesser individuals, including ourselves, are extensions. This in turn explains our inherited memories, instinctive fears, the so-called instincts of animals; our conscience and altruism; and immortality.

This whole new trend toward a spiritual interpretation of the world is opposed to the materialistic interpretation by which all events are simply the mathematical resultants of causes, without intervention of purpose; likewise it favors the vitalistic concepts of life which, however, seem to most men of science to border on mysticism. The author concludes that "religion and science are not in two compartments, as nearly all the leading theologians and nearly all the leading present men of science say they are." —$2.20 postpaid—*A. G. I.*

WE have been asked a number of times what the italicized initials mean that appear at the end of some of the book reviews. These are the initials of the reviewing editor.

***A. G. I.*—Albert G. Ingalls, Science**

***A. A. H.*—Albert A. Hopkins, Fine Arts**

***F. D. McH.*—Fred D. McHugh, Engineering**

***A. P. P.*—A. P. Peck, Radio, Television**

Where no initials appear the review is by L. S. Treadwell who has responsibility for this department and to whom should be directed any questions that you may care to ask concerning books or other subjects upon which you desire information. Our staff cannot always answer your queries (no small collection of men can possibly envision all knowledge) but it is seldom that we are unable to give some tangible reference.

WAVE MECHANICS—*By A. Sommerfeld, Prof. Physics, Munich*

THE rapid succession of published papers on the theory of the atom and on atomic phenomena generally makes it almost impossible for the ordinary physicist to realise the present position of his subject. Professor Sommerfeld has brilliantly performed the task of surveying all the recent important developments and has also treated a number of the older facts in a new way. The achievements of de Broglie, Heisenberg, Schrödinger and Dirac are clearly set out, and it is shown how the weaknesses inherent in the Bohr atom have in many cases been successfully overcome. The work is almost wholly written in higher mathematics.—$6.40 postpaid—*A. G. I.*

INDUSTRIAL REFRIGERATION, COLD STORAGE AND ICE-MAKING—*By A. J. Wallis-Tayler*

THIS seventh edition of an English work covers the entire subject most thoroughly in 162 pages, with a final chapter on small commercial and household refrigerating plants. It is a history of refrigeration as well as a text book of current practice and is a reference of international comprehensiveness.—$10.25 postpaid.

INDUCTION COILS—*By F. E. Austin*

THERE has been real need for a work on this subject because of its application to automobiles, telephony, wireless telegraphy, and X-ray diagnosis. This little volume so trenchantly and completely presented will be welcomed by those who have been unable to uncover this information in other sources. Specific instructions for building large and small coils to operate wireless outfits are also included. A most complete and satisfactory presentation.—$1.15 postpaid.

ABC OF GLIDING AND SAILFLYING—*By Victor W. Pagé*

GERMAN experience extending over a number of years has been largely drawn upon to furnish the material for this simple and practical treatise, prepared with special reference to the needs of young beginners in aviation. It gives diagrams of many of the important planes with details of materials used and the general construction. Formation of gliding clubs and details of training are adequately covered.—$2.15 postpaid.

THE CONQUEST OF LIFE—*By Theodore Koppanyi*

THE subject of this 256-page book is biology—anatomy, embryology, evolution, heredity, physiology—but it is not at all like a textbook, rather is it designed for pleasant, though serious reading. The author has chosen some of the "pleasant spots" of this big broad science and dwelt on them at considerable length and with more than considerable interest. The chapter on the endocrine glands and the one entitled "Masculine and Feminine" are especially notable.—$2.15 postpaid—*A. G. I.*

THE GREEN LEAF—*By D. T. MacDougal, Carnegie Institution*

THE "major activities of plants in sunlight" (sub-title of the book) have been kept too largely in the dark and many of us therefore think of plants as dull inanimate things. But Dr. MacDougal's new book—which, by the way, concerns mainly what goes on in the insides of plants, an aspect we seldom hear of—shows that they are almost as human and interesting as monkeys. The "visit to the green-leaf mills," in which we actually crawl into a manhole in a 100,000-times magnified leaf and climb around the interior, reveals what a lively chemical laboratory a leaf is. Other inquisitions on trees bring to light whole factories full of hustle and bustle and machinery, of which most of us are not aware, perhaps because, unlike animals, trees do not roar or bark. The author's life work has been devoted to research on these silent manufacturing centers and the book represents information at first hand from a noted man of

FROM RECENT PUBLICATIONS

science. In addition it is full of interest; for example, such things as that a healthy tree manufactures lumber at the rate of one broomstick a day.—$2.15 postpaid.—*A. G. I.*

THE MOUND BUILDERS—*By H. C. Shetrone, Dir. Ohio State Arch. and Hist. Soc.*

FOR a long period of years there has been no up-to-date, all-around treatise on the mound builders, but at last one has been published and it is a rarely good one. Dr. Shetrone, than whom no scientific authority is better fitted to write on this subject, has made a splendid round-up of the whole field. The book has two parts, 165 pages being devoted to the various cultural phases of the mound builders, while in the remainder of the 500 pages the known mounds, of which there are myriads, are taken up systematically region by region, state by state, from Gulf to Canada and Atlantic to the West, and dealt with in detail. Finally, the intriguing question "Who were the mounders?" is discussed scientifically. The style is wholly non-technical and replete with interest, while the handsome, rather large volume (6½ by 9½) is printed in good type on fine, heavy, filled paper, has 299 illustrations, and is attractively bound. This book doubtless will be *the* standard work both for reading and reference during many years to come.—$7.70 postpaid.—*A. G. I.*

THE SECRETARY'S GUIDE—*By C. O. Sylvester Nawson*

NO more useful little book has come to our desk in a long time. It covers thoroughly, in most condensed form, the correct modern usage for spelling, compounding, capitalization, punctuation, abbreviations, figures and numerals, sizes and styles of type, use of italic, spacing, proofreading, correspondence, and diction. It goes at once on our reference shelf and we predict it will be used frequently as its general utility is much greater than the name indicates.—$2.15 postpaid.

THE ENLARGEMENT OF PERSONALITY—*By J. H. Denison*

THIS is not a psychological treatise in the sense we generally understand that term, but a common sense discussion of the facts of consciousness which are a matter of common experience and of historic record and a suggested interpretation of them. If a man is given a new and different idea of what he is, that idea in many instances will so recondition his reactions that his behavior and character will be materially altered. The process and proof are carefully developed by the author.—$3.20 postpaid.

THE REAL WAR 1914 TO 1918—*By Captain B. H. Liddell Hart*

EXPERT diagnosis is usually so detailed and laboriously compiled that one reads with a considerable sense of compulsion. Here the author gives us a quick resume of the official facts and their significance. "The Origins of the War"—Chapter I—is the clearest, most comprehensive review that we recall reading. The stories of the various major engagements run smoothly and vividly. Facts are discussed and sentimental reputations are no bar to criticism and a fearless endeavor properly to evaluate the tactical value of leadership. We believe this work will rank high in the more analytical literature of the late war. 495 pages and a most complete index.—$4.20 postpaid.

NEW WAYS TO MAKE MONEY—*By Roger W. Babson*

"TO help young people in selecting a vocation which has a great future"—to quote the author. Incidentally we might add that the adult might well give it careful reading for the keen insight into industry and business which with swift, decisive, almost curt sentences outlines the various opportunities in a wide variety of lines of effort. There have been other good books on "Choosing a Profession" and so on, but none to our mind quite so inclusive yet almost statistical in its briefness, as is this text.—$2.65 postpaid.

ROUGH AND TUMBLE ON OLD CLIPPER SHIPS—*By Captain Bob Ramsay*

THIS rousing, hearty story by an old shell-back is vivid with life, character study and tales of feats of the fast clipper ship in strange seas and foreign ports. It relates adventures of shark fighting, mutiny, and stern discipline, material ranging from deep sea diving to navigation on the Great Lakes. Primarily, however, the real rough adventure which attended the heyday of navigation is the keynote. A real tale by a real sailor.—$3.20 postpaid.

THE WILD GRIZZLIES OF ALASKA—*By John M. Holzworth*

THREE years collecting material for the U. S. Biological Survey enabled the author to study the grizzly and big brown bear as well as mountain sheep and caribou. An experienced scientific observer with all the enthusiasm of the tenderfoot writes in conversational style of most adventurous experiences, many of which give an entirely different idea of these wild beasts from that generally understood by most of us. 95 beautiful photogravure illustrations.—$5.20 postpaid.

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AN accomplished Turkish girl of distinguished ancestry gives an intimate picture of the daily life of an official family during the period of the struggle for freedom from the tyranny of the times and of war. All the hopelessness of oppression, the hopefulness of brighter days ahead, the swaying back and forth of the fortunes of war and despotism are depicted with an extremely facile pen, to make a story that is truly unique in subject matter and viewpoint.—$3.20 postpaid.

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AN accurate description of some of the worst plagues that have afflicted the world and the way man found out about them and conquered. Also an appreciation of many of the valiant men and women who have been responsible for some of the most dramatic events in human history—a story abounding in pathos and heroism. The author is an expert in public health, so he brings to the subject sound knowledge and fervent enthusiasm.—$3.65 postpaid.

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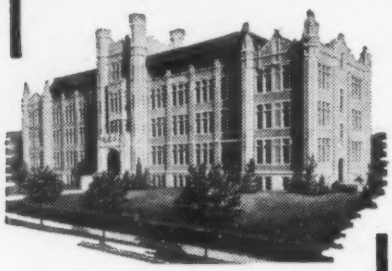

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